Construction Methods

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August, 1936

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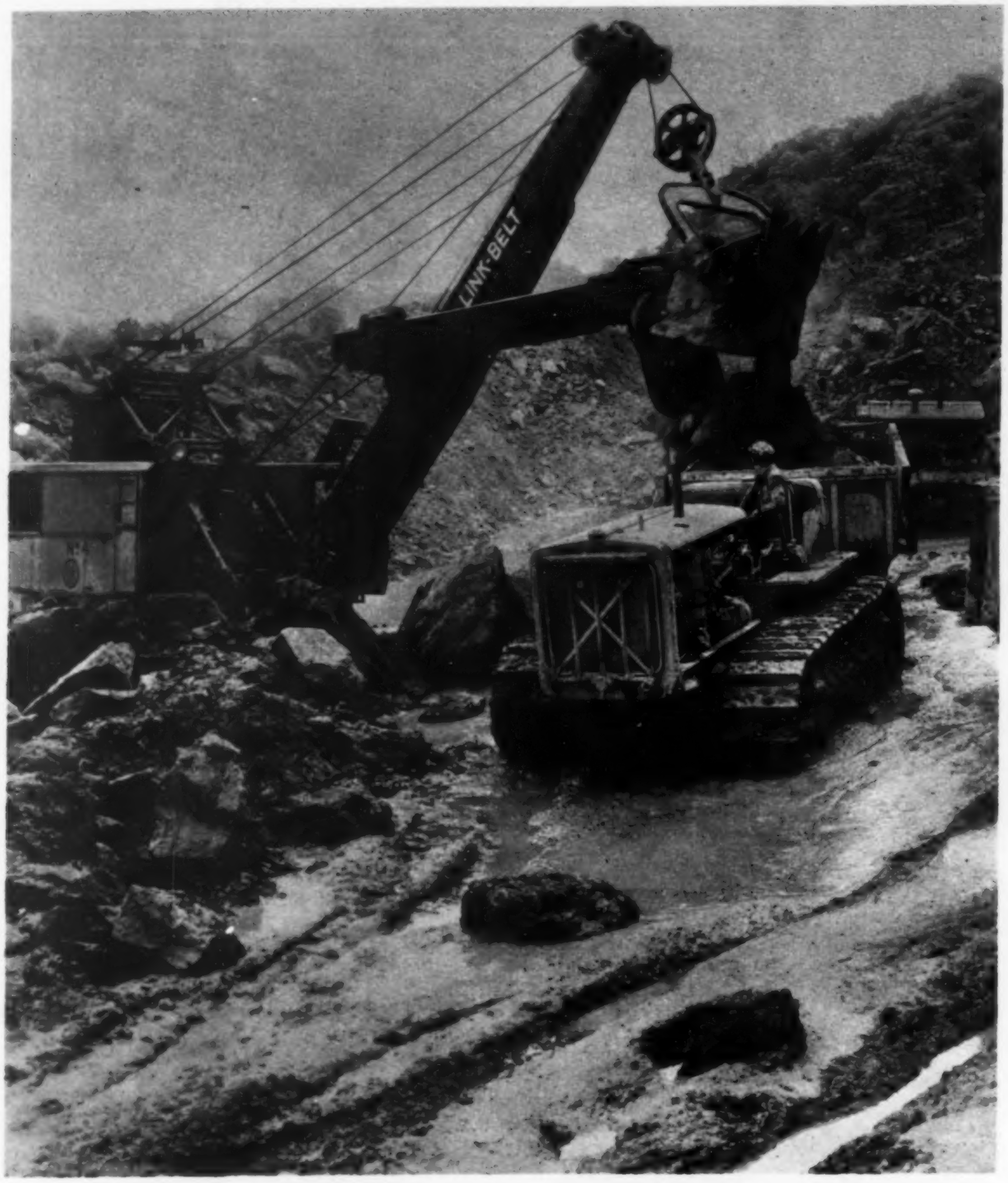
In This Issue:

STEEL TOWER of cable suspension span of Triborough bridge, $60,300,000 toll structure linking New York City's boroughs of Manhattan, Queens, and the Bronx, which was officially opened to traffic July 11 with ceremonies in which President of United States participated.


LINK-BELT

Construction Methods

McGraw-Hill Publishing Company, Inc.
330 West 42nd St., New York

ROBERT K. TOMLIN, Editor — AUGUST 1936 — WILLARD CHEVALIER, Vice-President

Editorial Staff: Vincent B. Smith, John B. Huttl (San Francisco)
Leonard H. Church (Cleveland), Nelle Fitzgerald

How—

. . . For the benefit of readers concerned with the practical application of method or equipment the following references are to articles or illustrations in this issue that tell:

Current Jobs

Buildings

Public—Twelve big slum clearance and mass housing projects were placed under contract last month by the Housing Division of the Public Works Administration. They are: Superstructure for Old Harbor Village housing project in South Boston, Mass., awarded to **Matthew Cummings Co.**, Boston, for $4,979,670; superstructure for Kinfield housing project, Buffalo, N. Y., awarded to **Fleisher Engineering & Contracting Co.** and **J. A. Bass**, of St. Paul, Minn., for $3,999,400; superstructure for Columbia Terrace housing project in Columbia, S. C., awarded to **T. A. Loving & Co.**, of Goldsboro, N. C., for $557,570; superstructure for Dixie Homes at Memphis, Tenn., awarded to **S. & W. Construction Co.**, of Memphis, for $2,329,026; superstructure for Cheatham Place housing project in Nashville, Tenn., awarded to **Foster & Creighton**, of Nashville, for $1,521,000; superstructure for Lucas Drive housing project in Dallas, Texas, awarded to **A. J. Rife**, of Dallas, for $802,900; Harlem River housing project, in New York City, awarded to **Cauldwell-Wingate Co.**, of New York, for $2,563,031; Rotary Park housing project in Oklahoma City, Okla., awarded to **L. Sanders**, of Oklahoma City, for $1,559,965; superstructure for Trumbull Park housing project, in Chicago, awarded to **George A. Fuller Co.**, New York City, for $2,533,300; superstructure for La Salle Place housing project in Louisville, Ky., awarded to **T. L. James & Co.**, of Ruston, La., for $1,048,200; superstructure for Andrew Jackson Court housing project in Nashville, Tenn., awarded to **J. Slotnik Co.**, of Boston, Mass., for $1,479,000; superstructure for Durkeeville housing project in Jacksonville, Fla., awarded to **H. S. Baird, Inc.**, of Jacksonville, for $850,317.

Other public building awards include a $1,369,652 U.S. post office and court house in Indianapolis, Ind., to **H. Dattner**, of Detroit; a $1,180,000 nurses' home in Brooklyn, N. Y., to **G. F. Driscoll Co.**, of Brooklyn; $2,508,700 for cadet barracks and academic building at West Point, N. Y., to **Charles T. Wills, Inc.**, of New York; a $1,081,000 U.S. narcotic farm building in Fort Worth, Texas, to **E. L. Martin**, of Fort Worth; a $2,003,000 state penitentiary building at Jefferson City, Mo., to **Pryor Construction Co.**, of Kansas City.

Commercial—In Cincinnati **Ring Construction Co.**, of that city, was successfull bidder for the $3,000,000 Colonial Homes housing project. A $1,500,000 15-story office building for the du Pont Company in Wilmington, Del., went to the **Turner Construction Co.**, of New York.

Industrial—Among awards for industrial buildings were a $1,000,000 Studebaker automobile factory in Los Angeles, Calif., to **Wm. P. Neil Co.**, of Los Angeles; a $2,750,000 paper mill for Union Bag & Paper Co., in Savannah, Ga., to **Merritt-Chapman & Scott Corp.**, of New York; a $5,000,000 power plant in South Chicago, Ill., for Carnegie-Illinois Steel Co., to **United Engineers & Constructors**, of Philadelphia; a $1,000,000 research laboratory in Detroit, Mich., for General Motors Corp., to **O. W. Burke**, of Detroit.

Bridges

One of the big bridge contracts last month was in Texas for the superstructure of the Neches River crossing at Beaumont which went to the **Taylor-Fichter Steel Construction Co.**, of New York, for $1,613,000. In Iowa, **G. V. Herrick**, of Des Moines obtained a $294,473 deck-girder structure in Polk County. To **James Stewart & Co., Inc.**, of New York, was awarded a $1,193,932 contract for covering New York Central railroad tracks in New York City. In Washington **Mac Rae Bros., of Seattle** were low with $229,086 for a railway underpass in Pasco, Wash.

For a lift span structure across Rockaway Inlet at Marine Parkway, New York, **Frederick Snare Corp.**, of New York, bid $1,595,338 for the substructure and **American Bridge Co.**, of New York, $2,139,311 for the superstructure. In Vermont, **Caputo Construction Co.**, of Boston, Mass., were low with a price of $373,871 for approach embankments and substructure of Missisquoi bridge at head of Lake Champlain.

AND WHO'S DOING THEM

Current Jobs

Highways

Among the larger road building contracts awarded were: $629,914 to **J. F. Lafferty**, of Haddon Heights, N. J., for a portion of Route 25 in Burlington County, N. J.; $333,653 to **Martin Wunderlich**, of Jefferson City, Mo., for grading, drainage structures and bridges on 16½ mi. of highway near Meridian, Miss.; $226,513 to **M. E. Engineering Co.**, of Albany, N. Y., for 3.8 mi. of road in Jefferson County, N. Y.

Waterworks

In Massachusetts, **Benjamin Foster Co.**, of Philadelphia, bid in for $2,317,445, embankment and spillway of main dam for Quabbin reservoir near Belchertown. A 32-mi. concrete pipe line, 39-43 in. in diameter at Little Rock, Ark., went to **Lock Joint Pipe Co.**, of Ampere, N. J., for $1,561,683. In Denver, Colo., a collecting conduit for the Moffat Tunnel water supply project was awarded to **Utah Construction Co.** and **Morrison-Knudsen Co.**, of Denver, for $573,572.

Sewers

A section of Wards Island sewage treatment works in New York was bid in by **Cauldwell-Wingate Co.**, of New York, for $1,547,175. Another sewage plant contract in Denver, Colo., went to **Peter Kiewits Sons Co.**, of Omaha, Neb., for $1,149,792. The **Henry W. Horst Co.**, of Philadelphia, received a $1,555,112 intercepting sewer contract in Buffalo, N.Y.; also in Buffalo, N.Y., a sewer award of $1,144,642 was made to **Frazier-Davis Construction Co.**, of St. Louis, Mo. Chicago gave to **Frazier-Davis Construction Co.** and **G. L. Tarlton, Inc.**, of St. Louis a $1,988,785 river control project.

Rivers and Harbors

For completing jetty at Grays Harbor, Wash., **Columbia Construction Co.**, of Bonneville, Ore., received a $2,799,458 award. In Florida, **Wilbanks & Pierce**, of New Orleans, bid low at $1,058,980 for construction of levee at Lake Okeechobee. At Clarksville, Mo., **Central Engineering Co.**, of Davenport, Ia., received a $1,635,789 contract for a concrete lock on Mississippi River.

Miscellaneous

Two large dredging contracts were let in Massachusetts, one to **M. A. Breymann Dredging Co.**, of New York, for $1,347,718; and the other to **Great Lakes Dredge & Dock Co.**, of New York, for $1,723,893. In Nebraska, **Woods Bros. Construction Co.**, of Lincoln, bid $507,398, for Missouri River control works. At Ft. Peck dam, in Montana, contract for steel lining in tunnel went to **Chicago Bridge & Iron Works**, for $909,961.

At Chariton, Ia., a railroad contract for the Burlington & Quincy, was obtained by the **Edward Peterson Co.**, of Omaha, Neb., at approximately $1,000,000. A boardwalk at Long Beach, N. Y., is being built for $682,769, by **Faircroft Engineering Co.**, of Brooklyn.

Worlds Fair Grading

Grading contract amounting to $2,186,185 for site of 1939 Worlds Fair on Flushing Meadows, Long Island, N. Y., was placed with **Arthur A. Johnson Corp.**, of Long Island City, N. Y., and **Necaro Co., Inc.**, of Brooklyn, N. Y. Job involves moving 7,000,000 cu.yd. of earth.

AND WHO'S DOING THEM

Solve the Problems *by* Selling the Prospects

FROM THE lumber industry comes the news that its leaders have gone in for an intensive session of fact-facing and have decided to seek its salvation in aggressive trade promotion rather than in the turn of Fortune's wheel or in some device to weight that wheel to its advantage.

As part of this effort services are being established to help constructors in many fields to use lumber more effectively. Instead of simply offering a raw material and daring the user to figure out a way to make it work, the lumber industry is taking a tip from some of its competitors and offering its product in better shape to meet the needs of the user. In other words, the problems of the industry are to be met on a basis prescribed by the needs of those who might use lumber rather than of those who would like to sell some.

All this is just another symptom indicating a revival of the old-fashioned idea that any industry should solve its problems by selling its prospects. For some years back quite a few industrialists have cherished the notion that the way to solve an industry problem is first to determine what is most agreeable to the proprietors of that industry and then to make its prospects take that and like it. If, for some reason, that policy should not produce results, the next step would be to invoke the power of government to keep wayward members of the industry in line and to make the customers sit up and eat their spinach.

BUT IT APPEARS that all this just raises another problem: how to enlist the powers of government without raising "governmental interference." Or, to put it more accurately, how to get government into business for what one wants and keep it out for what one doesn't want.

At that point the whole matter becomes very complicated, especially when industries that produce competitive types of product or services decide that here is a break for them. While the "ins" are preoccupied with "industry control", "stabilization" and "governmental cooperation", the "outs" come in and mess up the market with some old-fashioned, "sell-the-customer" competition. For this the remedy seems to be either more governmental control to keep the competing industries in line or else chuck the whole sorry business and get back to work.

Today the trend toward the latter solution is increasingly clear. This is encouraging, not only because it is rational, but also because it is a convincing demonstration that industry itself is putting the depression behind it. Today it is less interested in cooperative protection than it is in competitive production; less interested in prorating than in prospects; less interesred in stabilization than in selling.

Every thoughtful industrialist knows deep down inside him that under our system there is only one road to industrial success: make a product or render a service that people need; produce it so efficiently that you can sell it at a price that more and more people can afford to pay; keep on telling more and more people about it over and over again.

EMERGENCIES give birth to many inventions calculated to suspend these simple rules; avarice, despair or wishful thinking may convince men that these rules can be superseded in their interest. But whatever emergency value such inventions may have and however seductive may be the formulas for "stabilization", it remains eternally true that there can be no royal road to success under a truly competitive system. Either we compete or we do not compete; we cannot have it both ways.

And unless we wish to abandon or change materially the whole system under which we have been working, we may as well be reconciled to the elementary formula: "make it right, price it right, sell it for all you're worth." Every time we do succeed in beating that formula we are but undermining the existing order to that extent; every time we seek a cure for an industry's ills in governmental regulation we are but going in for a powerful drug that may in the end sap the health and vigor of that industry.

Willard Chevalier

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The special coal hauling Bottom Dump Trac-Truk having a 24 cu. yd. water level capacity and a rating of 20 tons

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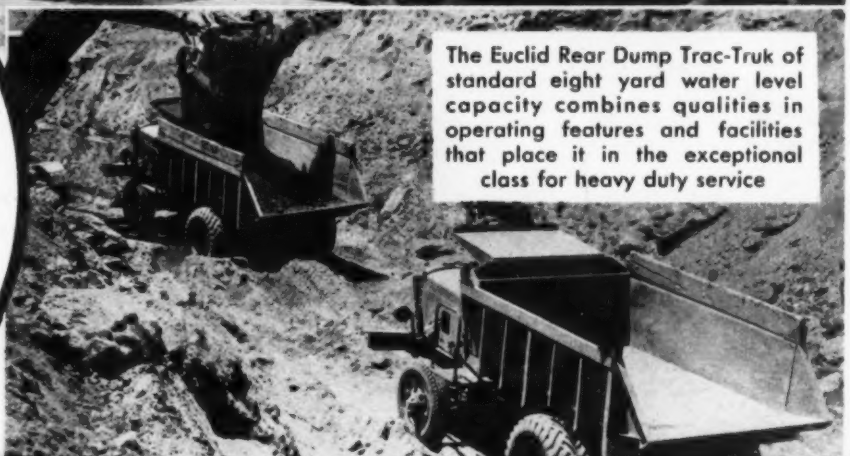
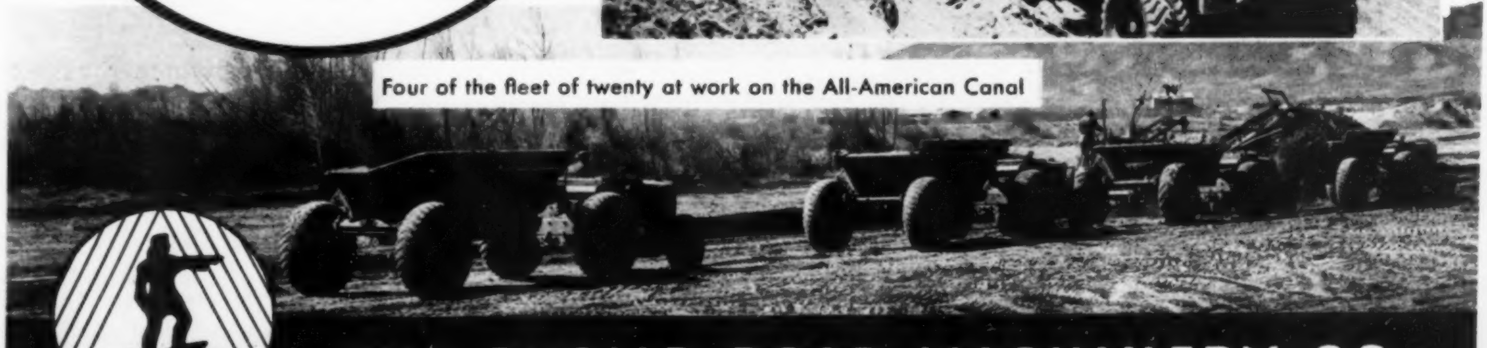
An opportunity to study and render advice on your hauling problem, without obligation, is invited



The Euclid Rear Dump Trac-Truk of standard eight yard water level capacity combines qualities in operating features and facilities that place it in the exceptional class for heavy duty service



Four of the fleet of twenty at work on the All-American Canal

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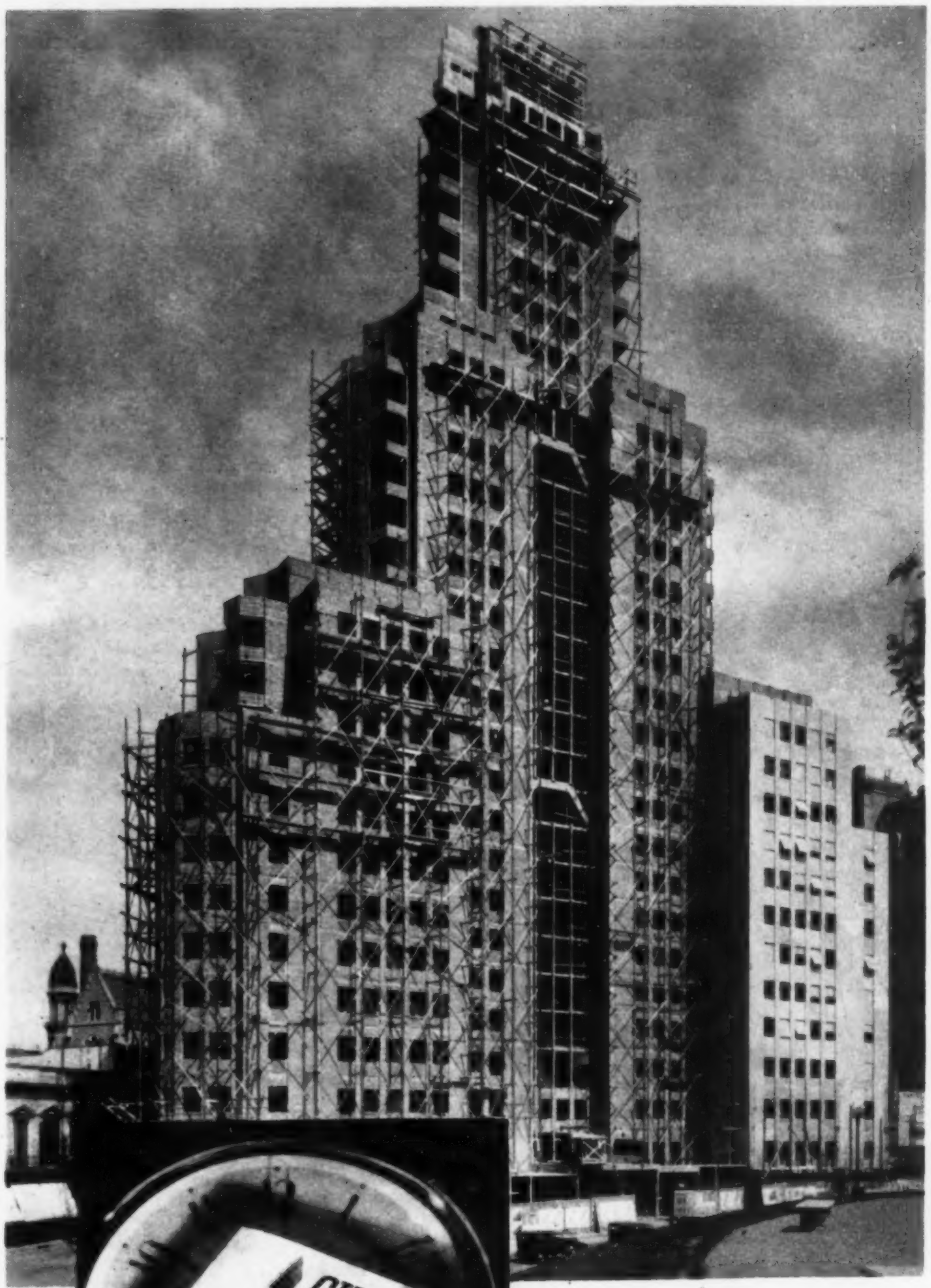
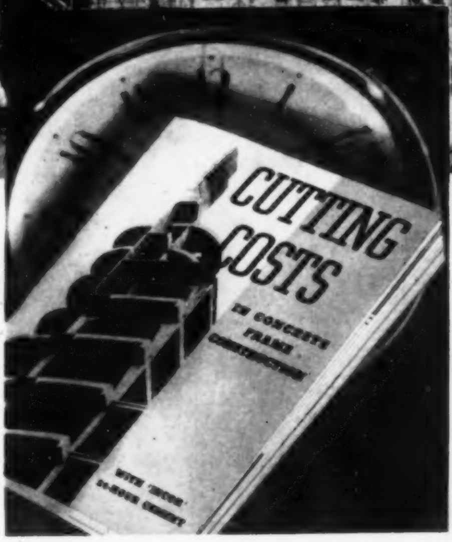
CUTTING COSTS

IN CONCRETE FRAME CONSTRUCTION





FRAME-ERECTION costs divide two ways — direct costs for labor and materials, and indirect or overhead costs. Direct costs are pretty well fixed by job conditions; but indirect costs can often be substantially reduced by careful planning—and particularly by eliminating non-productive time. That is, by saving the time lost while ordinary concrete cures or hardens — "dead" days when frame-erection stands still and fixed overhead expense runs on.

Erection Schedules Analyzed

To save this non-productive time, the contractor can either build extra forms or use 'Incor' 24-Hour Cement, whichever is cheaper. But when to use which — that is the question. To get the answer, 80 typical erection schedules were analyzed. Results are summarized for quick reference in this new book (right).

This book shows, for both a 5- and 6-day week, the number of days required to erect and cure concrete frames, 1 to 16 floors, for four different form-assembly periods, with one and two sets of forms. It shows non-productive days saved by using 'Incor.'

Substantial Savings Shown

Thus, for any given overhead, you can quickly figure whether 'Incor' saves more than it costs. Since conditions vary widely from job to job, no specific costs are given — but you can easily figure the savings with the information supplied in this book. It's a quick, easy, accurate method — and usually the savings are well worth the estimating.

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(Above) Kavanagh Building, Buenos Aires, world's tallest reinforced concrete building. Cement furnished by International Cement Corporation's Argentine subsidiary.

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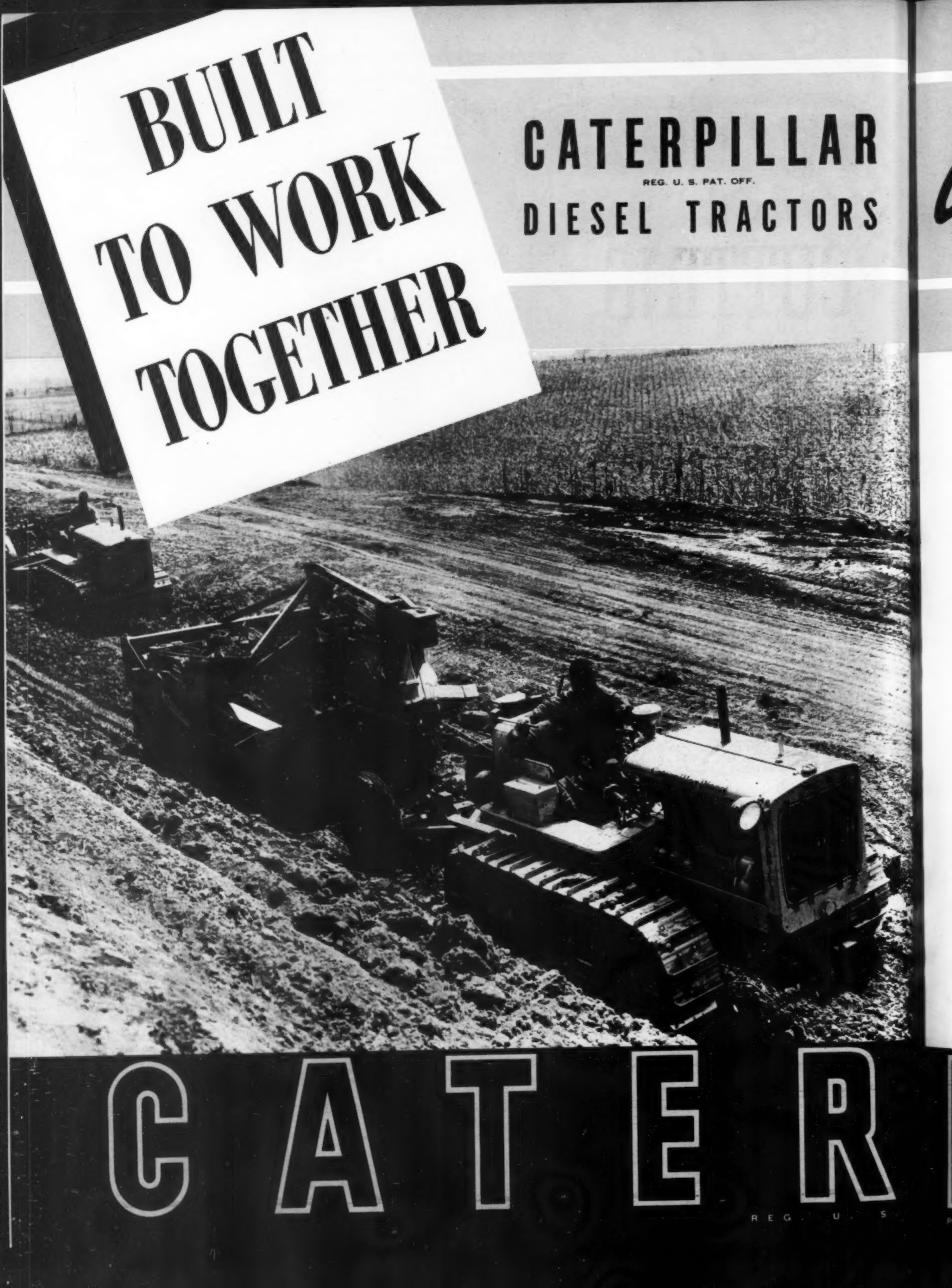
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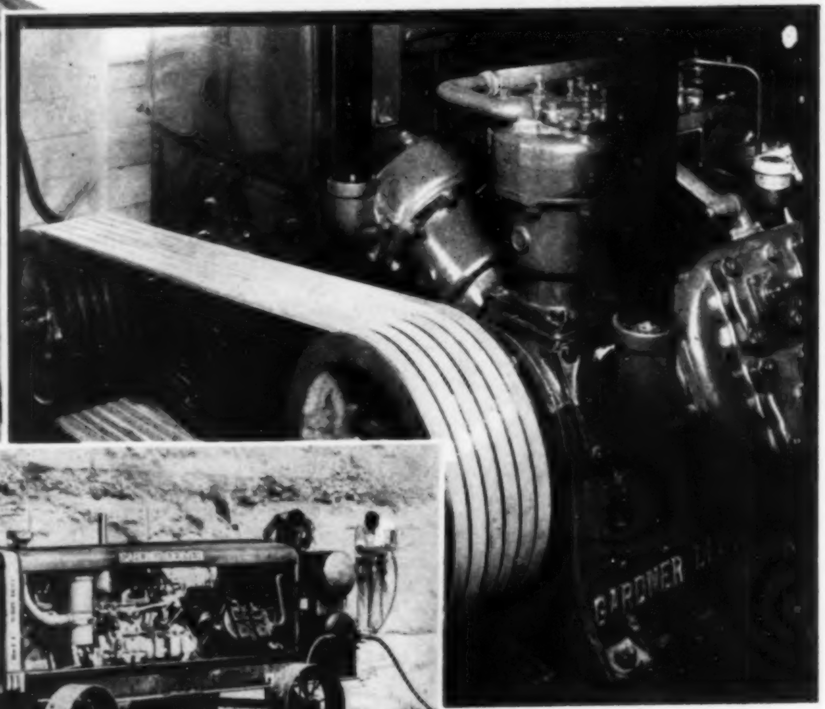

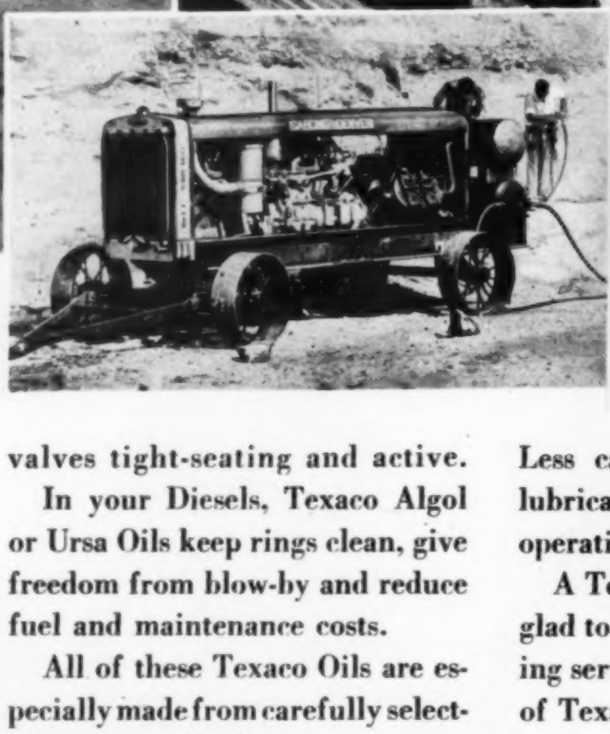

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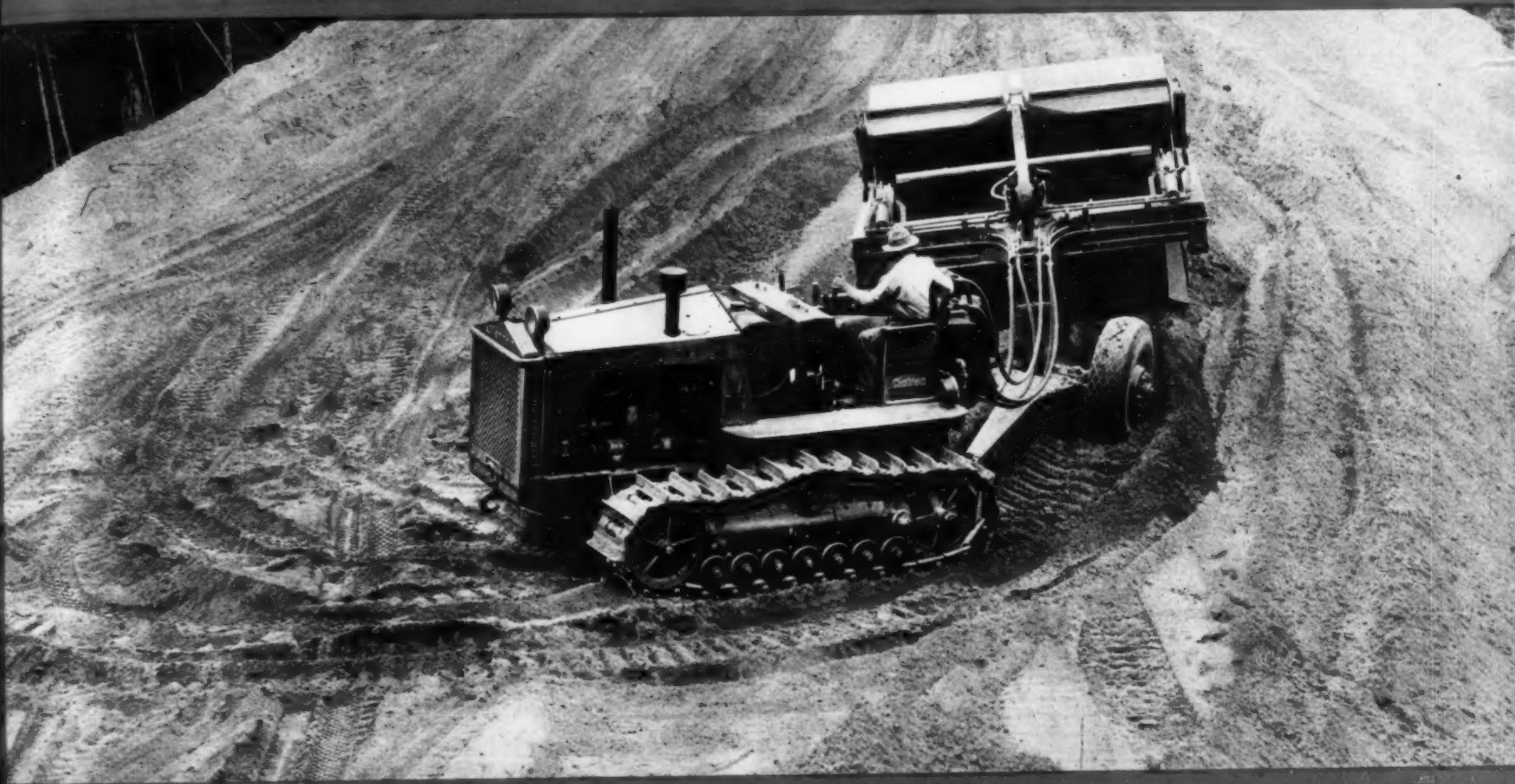

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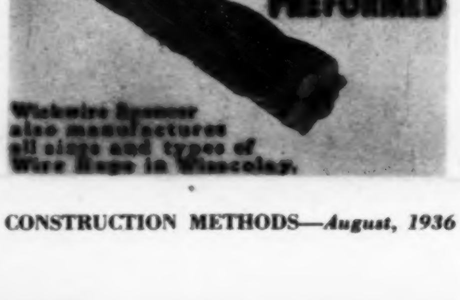

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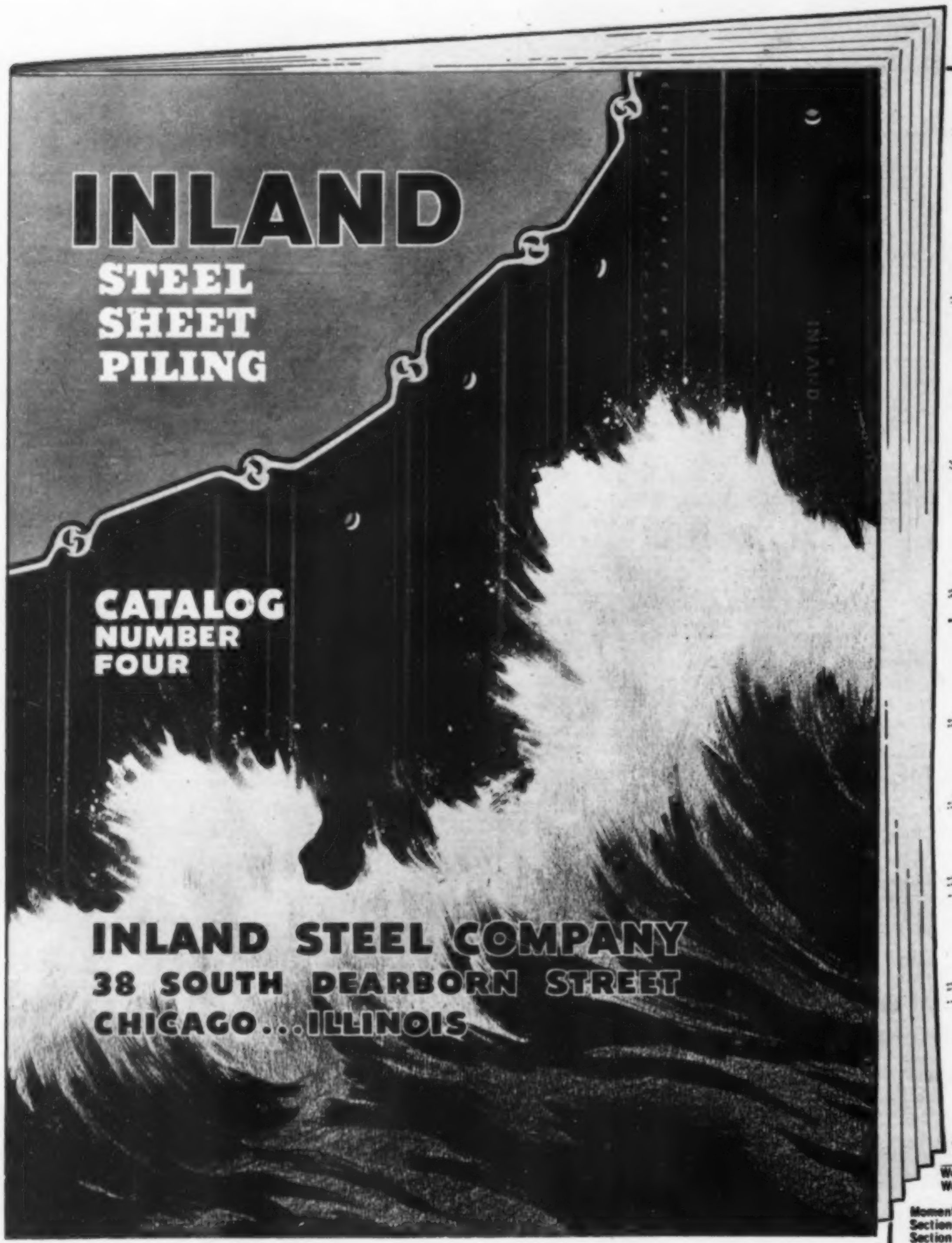
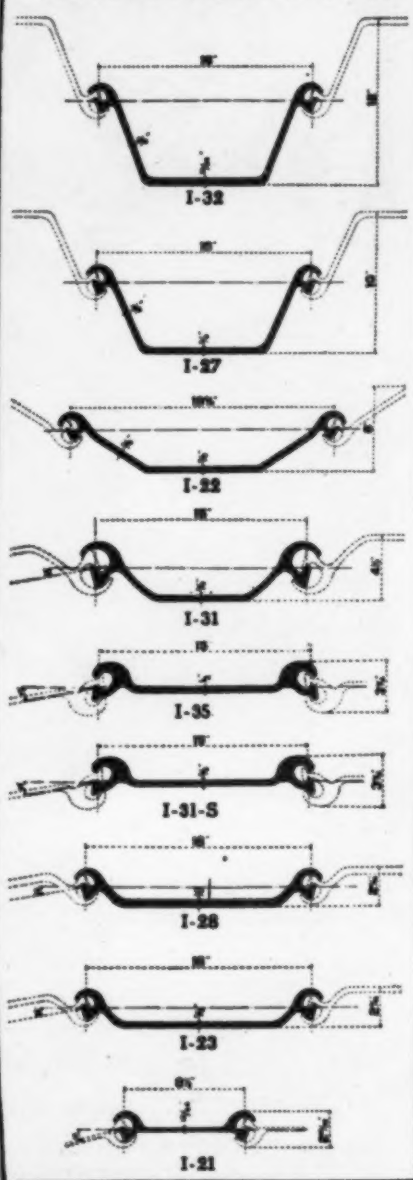


INLAND SECTIONS



SECTION	I-32	I-27	I-22
Weight per foot	42.7 lbs.	36.0 lbs.	36.0 lbs.
Weight per sq. ft. of wall	32.0 lbs.	27.0 lbs.	22.0 lbs.
Moment of inertia	87.0 in.^{4}	53.0 in.^{4}	22.4 in.^{4}
Section Modulus	20.4 in.^{3}	14.3 in.^{3}	8.8 in.^{3}
Section Modulus per lineal foot of wall	15.3 in.^{3}	10.7 in.^{3}	5.4 in.^{3}
Section Modulus per foot interlocked	24.5 in.^{3}		
Strength of interlock per lineal in. in direct tension	8,000 lbs.	8,000 lbs.	8,000 lbs.

SECTION	I-31	I-35	I-31-S
Weight per foot	38.8 lbs.	43.8 lbs.	38.8 lbs.
Weight per sq. ft. of wall	31.0 lbs.	35.0 lbs.	31.0 lbs.
Moment of inertia	17.9 in.^{4}	6.1 in.^{4}	6.0 in.^{4}
Section Modulus	8.1 in.^{3}	3.8 in.^{3}	3.7 in.^{3}
Section Modulus per lineal foot of wall	6.5 in.^{3}	3.1 in.^{3}	3.0 in.^{3}
Strength of interlock per lineal in. in direct tension	10,000 lbs.	12,000 lbs.	12,000 lbs.

SECTION	I-28	I-23	I-21
Weight per foot	37.3 lbs.	30.7 lbs.	14.9 lbs.
Weight per sq. ft. of wall	28.0 lbs.	23.0 lbs.	21.0 lbs.
Moment of inertia	6.0 in.^{4}	5.5 in.^{4}	1.0 in.^{4}
Section Modulus	3.3 in.^{3}	3.2 in.^{3}	1.0 in.^{3}
Section Modulus per lineal foot of wall	2.5 in.^{3}	2.4 in.^{3}	1.4 in.^{3}
Strength of interlock per lineal in. in direct tension	12,000 lbs.	12,000 lbs.	8,000 lbs.

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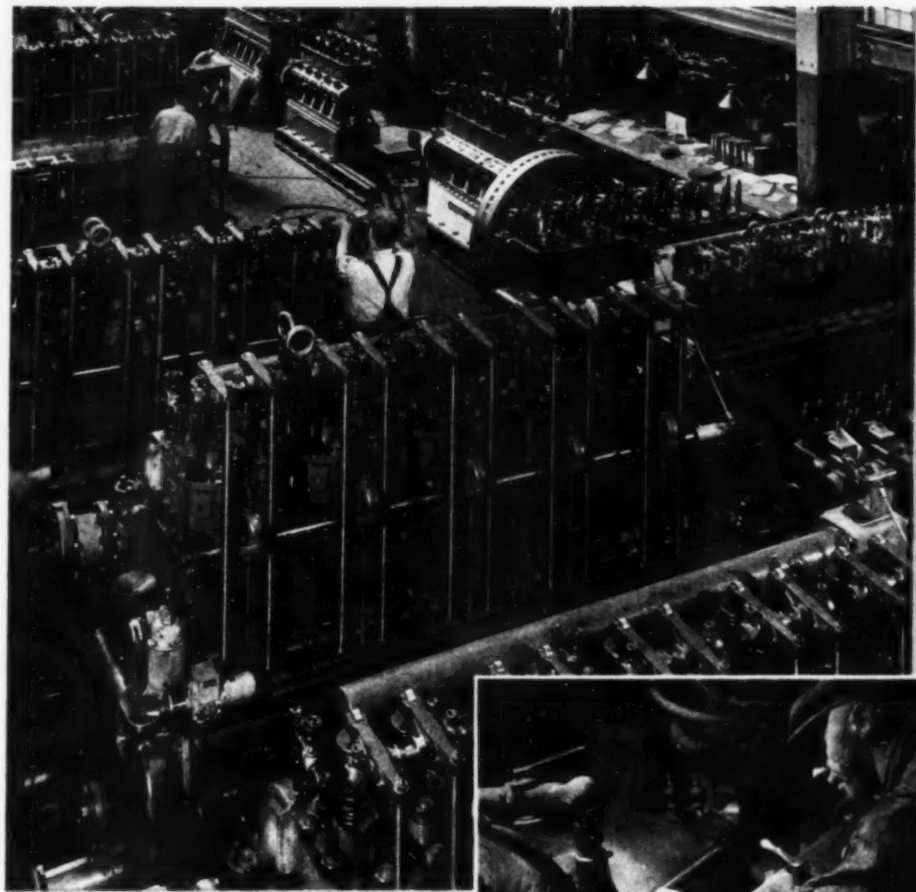
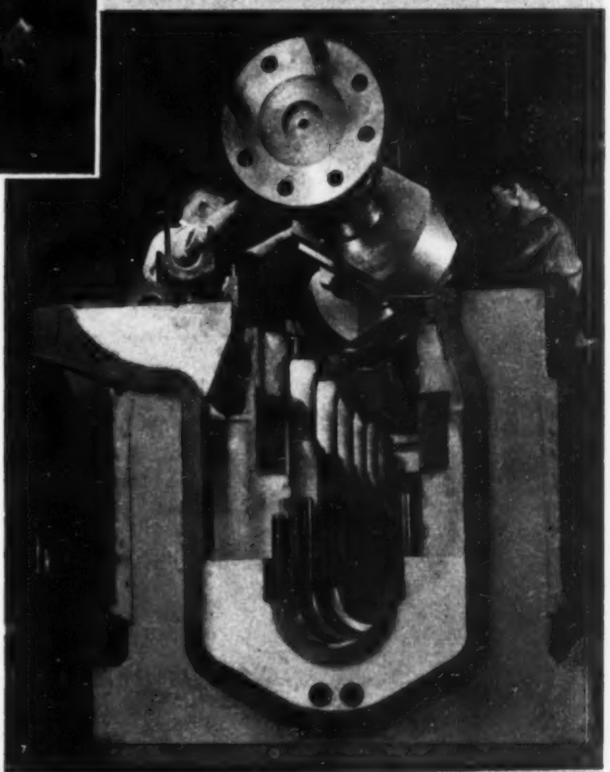


DIESELS ARE BUILT WITH CLOSE TOLERANCES

GULF PARVIS OILS PRESERVE THEM

It takes months to build a large Diesel engine. It must be assembled, tested, torn down for inspections and re-assembled. Above is the assembly floor in the plant of a large builder. Gulf lubricants are used for engine "run-ins" and for the lubrication of all mechanical equipment throughout the plant.

Each piston must be accurately built for its individual engine. At the left, a mechanic is carefully calibrating the diameter of a piston which he is grinding to exact size.



Great care has been taken in finishing this shaft to extreme accuracy and balance and to provide a perfect fit for bearings and shaft journals. Gulf Parvis Oils minimize wear and preserve close tolerances.

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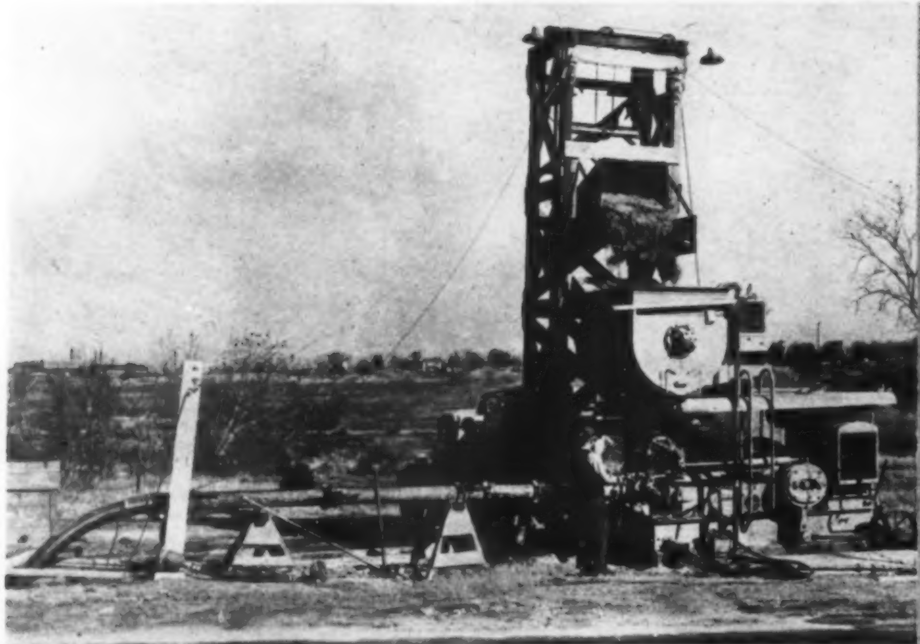

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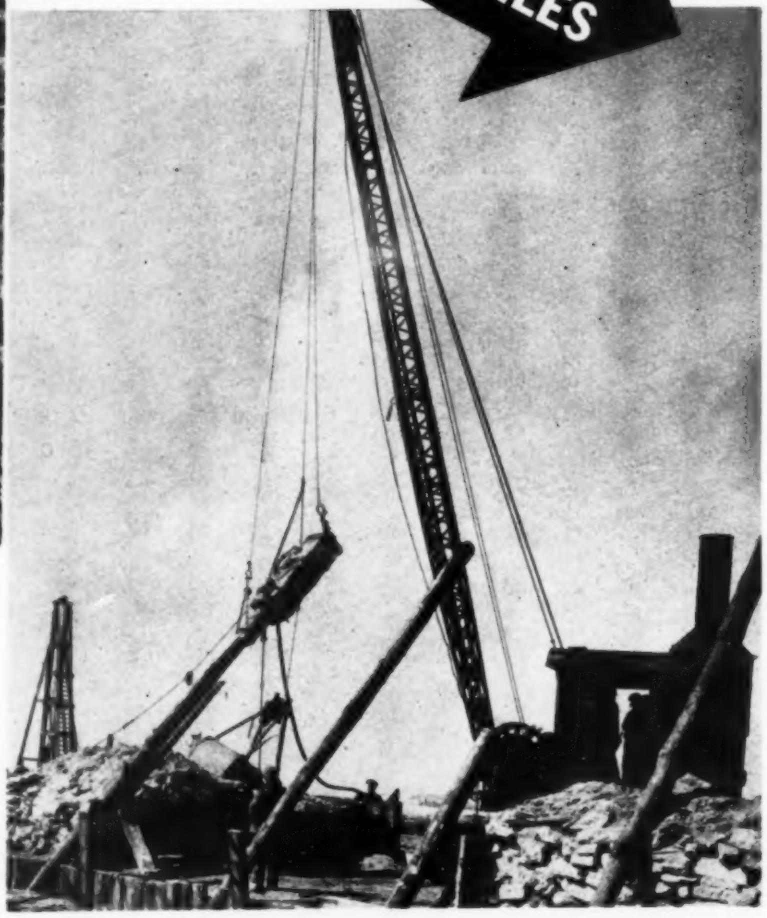

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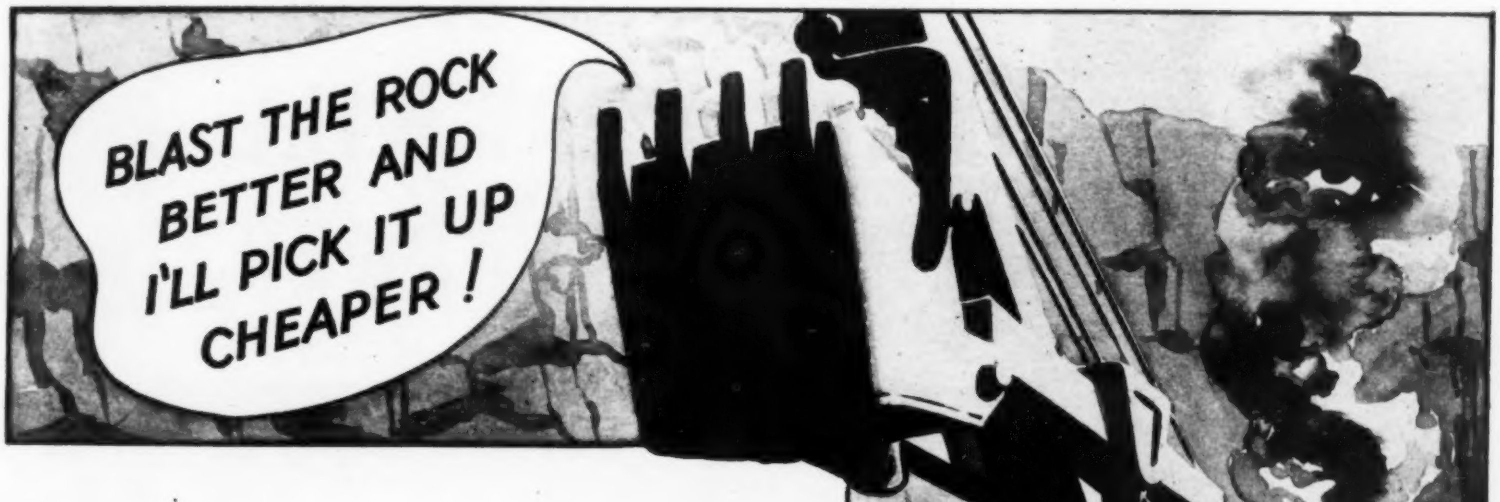

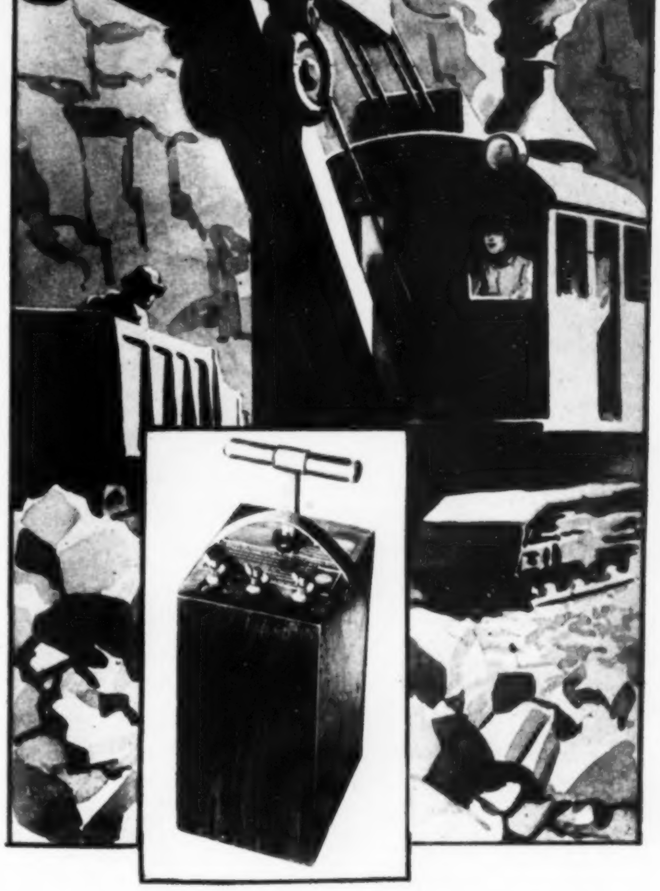

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EXPLOSIVES

CHEMICALS ATLAS EXPLOSIVES

Construction Methods

ROBERT K. TOMLIN, Editor

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THREE BRIDGES

Win Awards in Annual Contest

BEAUTY in steel bridge design received annual recognition with the recent awards by the American Institute of Steel Construction to the most beautiful bridges completed last year in three cost groups. A jury appointed by the Institute chose the North Grand Island bridge, Niagara Falls, New York, as the most beautiful among structures costing more than $1,000,000, the Lorain Road bridge, Cleveland, Ohio, as the best in the $250,000 to $1,000,000 group, and the Mortimer E. Cooley bridge, near Wellston, Michigan, as the most pleasing of those costing less than $250,000.

Superstructure design of the North Grand Island bridge embraces eleven deck truss spans. A main span 500 ft. long is flanked by symmetrical truss spans of 400, 350, 300, 250, and 200 ft. Superstructure plans were prepared for the Niagara Frontier Bridge Commission by Waddell & Hardesty and Geo. C. Diehl, Inc., consulting engineers, under the direction of Frederick S. Greene, chief engineer of the commission and superintendent of public works of the State of New York. Structural steel was erected by the Taylor-Fichter Steel Construction Co., of New York City, and was fabricated under subcontract by the Jones & Laughlin Steel Corp. in conjunction with the Fort Pitt Bridge Works.

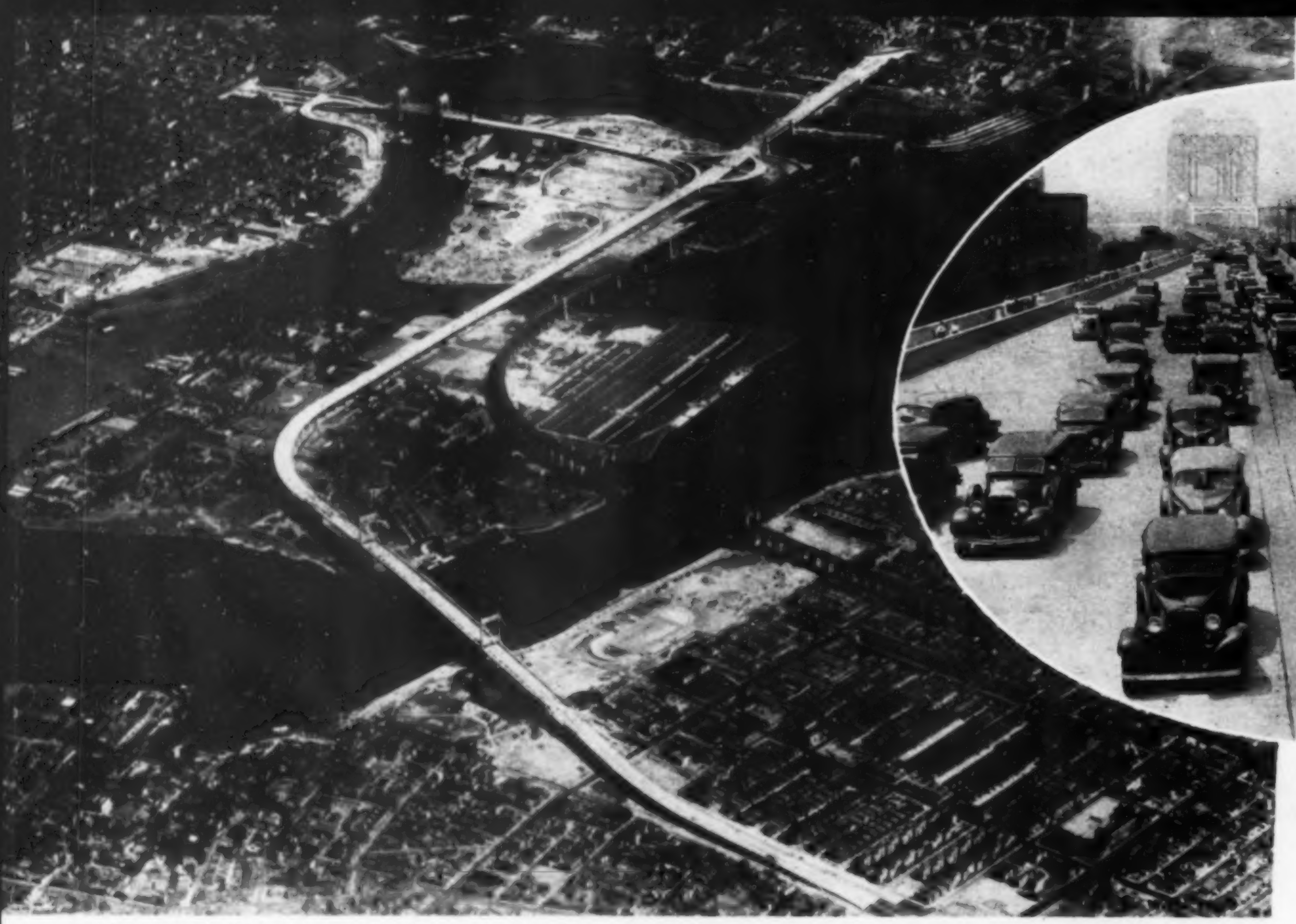

PRIZE-WINNING BRIDGE in first group has eleven deck truss spans carrying 24-ft. roadway and 6-ft. sidewalk between Niagara Falls, N. Y., and Buckhorn Island, at north end of Grand Island, in background.


SMOOTH SURFACES (achieved by butt-welding joints before riveting concealed splice plates) prominent, unlaced pier towers, and suppression of cross-bracing characterize architectural treatment of Lorain Road bridge, Cleveland.

Four steel arches of 256- and 236-ft. span in the prize winning bridge of the second group carry Lorain Ave. across Rocky River, Cleveland. The design was made in the bureau of bridges of the Ohio Department of Highways, under the direction of J. R. Burkey, chief engineer of bridges; W. H. Rabe, chief designing engineer; and D. H. Overman, principal designing engineer in charge of this project. Structural steel was fabricated by the Fort Pitt Bridge Works and was erected by the Peoples Steel Co., of Cleveland, both acting as subcontractors under the Lowensohn Construction Co., of Cleveland, general contractor.

In the third group the winner of the award was designed by L. W. Millard, bridge engineer of the Michigan State Highway Department. Structural steel was fabricated and erected by the Wisconsin Bridge & Iron Co.

MICHIGAN BRIDGE *(below)* carrying state route 55 across Manistee River has 350-ft. main span and two 125-ft. anchor arms.

International News Photo

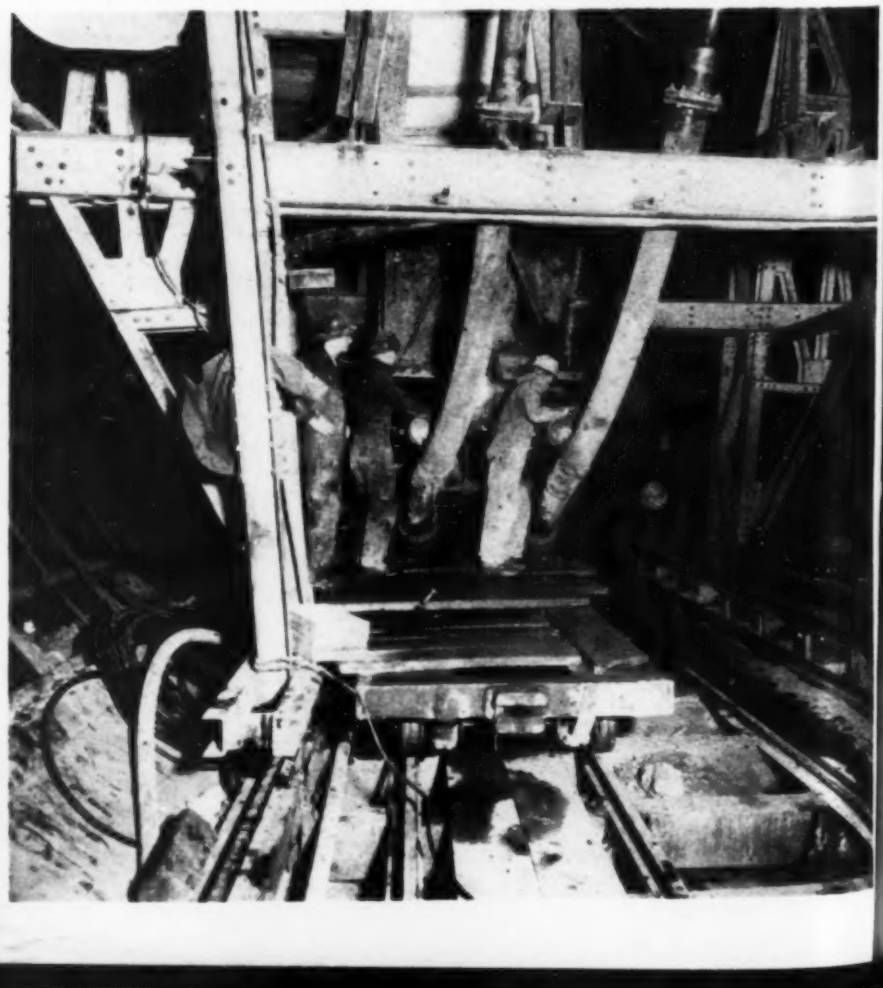
FIRST TRAFFIC crosses Triborough bridge after structure was placed in service July 11, following dedication by President Franklin D. Roosevelt.

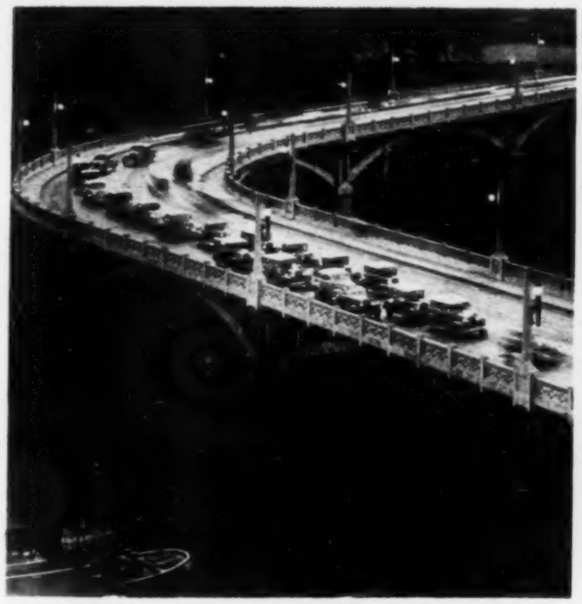
TRIBOROUGH BRIDGE, New York City, completed at cost of $60,300,000 (including approaches) links borough of Queens (lower right corner) with Manhattan at 125th St. (upper left) and the Bronx (upper right). Existing Hell Gate bridge of N. Y. Connecting Railway is at right of new concrete-paved vehicular structure which, starting at Astoria, L. I., crosses Hell Gate branch of East River with main 1,380-ft. cable suspension span to Ward's Island, continues to traffic circle on Randall's Island and splits into two branches, one going to Manhattan via Harlem River lift-span and the other extending to the Bronx along steel truss structure over Bronx Kills. Bridge, including 14 mi. of highway connections, was designed and constructed under direction of Triborough Bridge Authority, of which Robert Moses is commissioner, O. H. Ammann, chief engineer, Allston Dana, engineer of design, and Col. H. W. Hudson, engineer of construction.

This Month's "NEWS REEL"

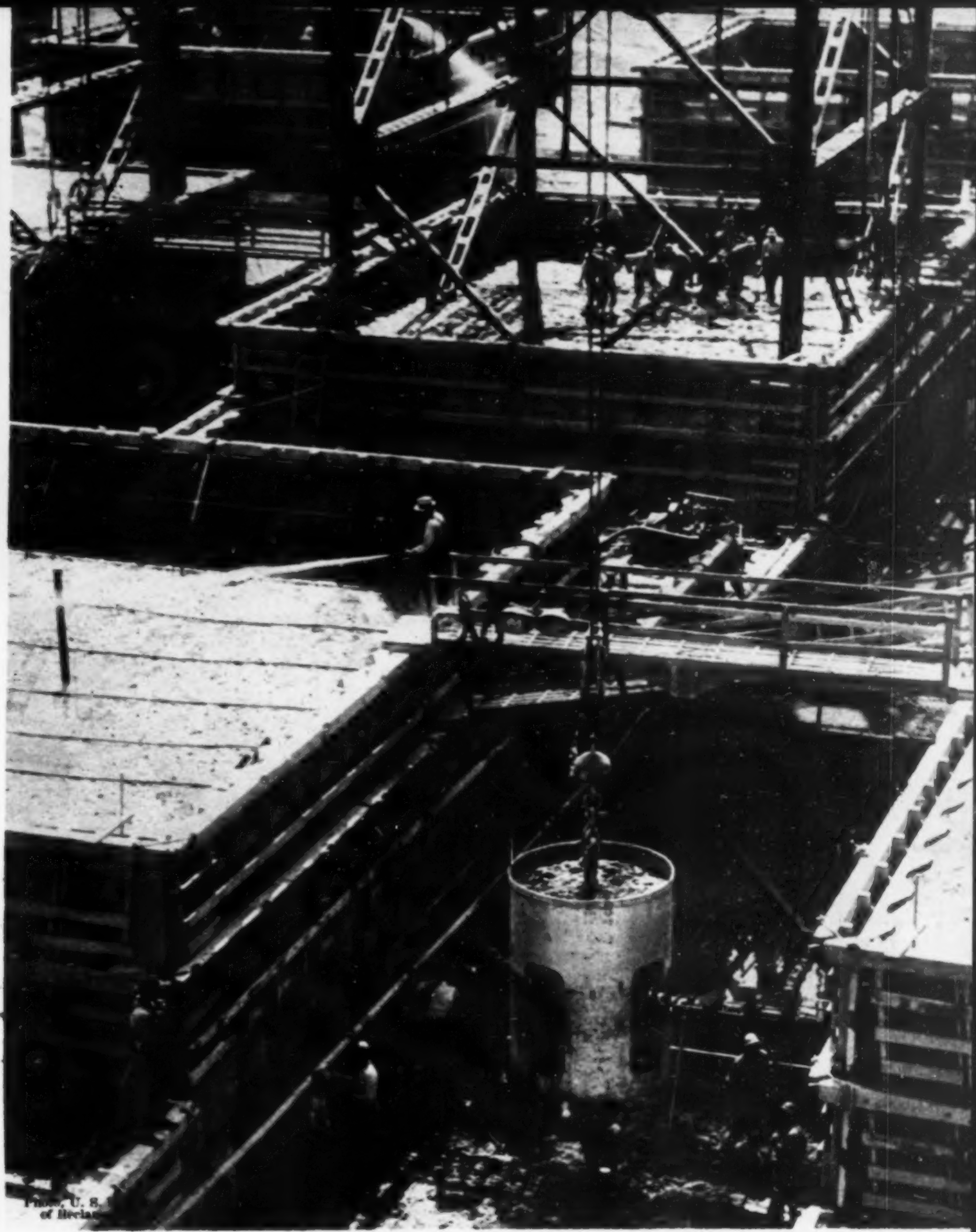
COLORADO RIVER AQUEDUCT construction in southern California proceeds as section of steel form is lowered into place for Eagle Mountain siphon on 33,175-ft. contract section for conduit and siphons awarded to Three Companies Inc. by Metropolitan Water District.

LINING (*below*) one of the big diversion tunnels at Fort Peck dam on Missouri River in Montana is done with Pumpcrete outfit which delivers mix through pipe lines into arch forms. Tunnel has outside diameter of 32 ft. 2 in. and thickness of concrete lining varies from 36 to 45 in. Work is being done by Army Engineer forces under direction of Lieut.-Col. T. B. Larkin, Corps of Engineers, U. S. Army, district engineer.

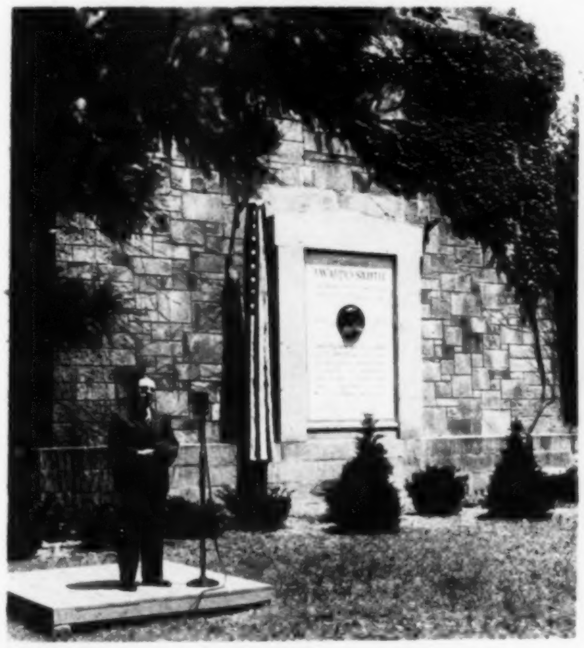




GOLDEN GLOW of 67 sodium-vapor electric lamps illuminates 5-lane roadway for night traffic across Western Gateway bridge on Albany-Schenectady, N. Y., highway. Rated at 10,000 lumens each, the new General Electric lamps are staggered 150 ft. apart along the bridge deck.



6,000 CU. YD. A DAY is the rate at which concrete is being poured in the west abutment of Grand Coulee dam, U. S. Bureau of Reclamation structure on Columbia River in Washington. Batches from central mixing plant are delivered in 4-yd. bottom-dump buckets by hammerhead and whirler cranes on steel trestles which are embedded in the dam as the concrete rises. Note water curing of concrete by man at end of bridge connecting two of the blocks forming main body of dam.



MEMORIAL TO J. WALDO SMITH, former chief engineer of the Board of Water Supply, City of New York, was unveiled June 25 at triangulation tower near Ashokan dam, near Kingston, N. Y., in recognition of his services, from 1903 until his death in 1933, in building the Catskill aqueduct. Inscription on plaque reads: "Man of vision and of courage, leader and counselor of men, student of the human heart, he inspired his associates and adorned his profession. The Catskill water system is his enduring monument."

LONGEST HINGELESS ARCH *(right)* in the world, as well as longest plate-girder arch of record, 800-ft. main span of Henry Hudson bridge, New York City, extends two arms from abutments toward final closure above Harlem River, July 8. Silicon steel box girder ribs 12½ ft. deep and 3½ ft. wide, spaced 50 ft. on centers, are carried by steel falsework bents resting on groups of steel H-piles 100 and 190 ft. out from each abutment. American Bridge Co. erected steel for Henry Hudson Parkway Authority. Madigan & Hyland are consulting engineers to Authority, and Robinson & Steinman of New York City are designers of bridge.

WELDED BAR TRUSS REINFORCEMENT for outer lane of new deck on Queensboro bridge is in place and truck-mixed concrete is being chuted into forms.

BRIDGE DECK MODERNIZED

With Concrete Slabs Reinforced by Welded-Truss Mats

ON NEW YORK CITY'S most heavily traveled bridge, the Queensboro cantilever span across the East River, the creosoted wood block paving with which the roadway of this structure was originally surfaced and which has involved costly and almost continuous repairs, is being removed, together with its supporting deck, and replaced with deck slabs of concrete mechanically vibrated and reinforced with welded steel bar trusses prefabricated in mats. The new roadway, it is believed, will not only make a drastic cut in pavement maintenance charges but also will be effective in reducing the number of traffic accidents which have been occurring,

OLD WOOD BLOCK PAVEMENT *(left)*, slippery when wet, is removed by air-operated paving breaker and hand picks.

STIFFENED STEEL PLATES of early floor system are cut out between the bridge stringers with oxyacetylene torch.

STEEL FLOOR PLATES have been burned out and removed, leaving opening for new concrete deck slabs.

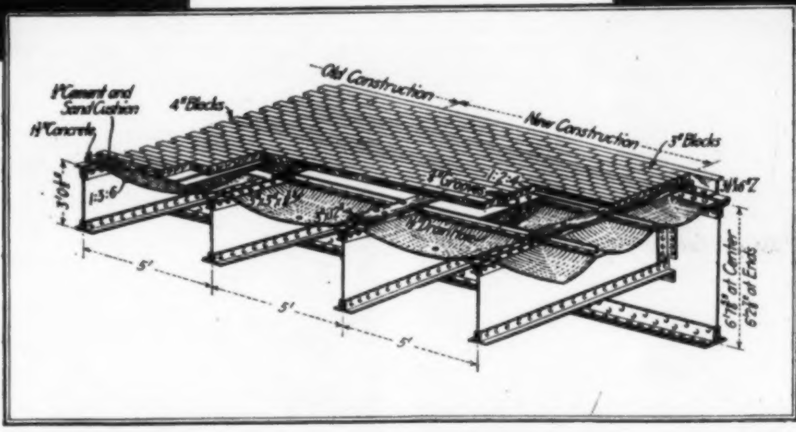
PLYWOOD FORMS for concrete slabs of new bridge deck are set in panels from which old steel floor plates have been removed.

particularly during wet weather when the wood block pavement, lubricated by drippings of oil and grease from passing motor cars and trucks becomes so "slick" that skidding is a common occurrence, even when cars are driven at slow speeds. A similar type of concrete deck also is being installed on the Williamsburg bridge, another East River crossing, to provide a two-lane roadway in space formerly occupied by street car tracks, recently abandoned. While differing in detail, the general character of the deck reconstruction work on both structures is essentially the same and the following notes deal mainly with the repaving operations on the Queensboro bridge, which are being carried on with WPA labor (J. J. Graham, superintendent) under the immediate supervision of S. Hamburger, engineer in charge of the bridge for New York City's Department of Plant and Structures, of which John A. Knighton is chief engineer and F. J. H. Kracke, commissioner; for the Williamsburg bridge J. Frank Johnson is engineer in charge.

Bridge Traffic—The Queensboro bridge, built at an original contract price of $13,496,500 and opened to traffic March 30, 1909, is a continuous steel cantilever structure, without suspended spans. Supported by four steel towers (two at the shore ends and two on Welfare Island, in the middle of the river) the bridge connects the Borough of Manhattan at East 59th St. with the Borough of Queens, at Long Island City, and has a total length, including approaches, of 8,600 ft. Its main roadway, 54½ ft. wide on approaches and 51 ft. on main river spans, carries five lanes of traffic whose recent volume (including traffic on a supplementary 2-lane roadway on the upper deck) has reached the enormous total of 109,000 vehicles per 24 hr. This traffic volume compares with about 54,000 vehicles daily for the Holland vehicular tunnel under the Hudson River between New York and New Jersey and 49,000 vehicles daily for the Williamsburg bridge, between Manhattan and Brooklyn. Today's traffic volume on the Queensboro bridge has increased more than tenfold since 1915 when a 24-hr. count showed 9,505 vehicles (of which 1,594 were horse drawn); a report at that time stated, naively, that "the traffic on Queensboro bridge has become extremely heavy."

Original Floor System—As originally built more than 27 years ago the

S. HAMBURGER, *(at right)* engineer in charge of Queensboro bridge for Department of Plant and Structures, discusses day's work with J. J. Graham, WPA superintendent on project.



ORIGINAL FLOOR SYSTEM of Queensboro bridge, now being replaced, consisted of steel buckle plates and wood block paving on concrete base.

Queensboro bridge roadway was carried by a system of plate girder floor beams and stringers spaced 5 ft. on centers, supporting ⅜-in. steel buckle-plates paved with wood block to minimize the dead weight of the deck. Filling the 3-in. depressions in the buckle plates and extending 1½ in. above their top surfaces was a course of 1:3:6 concrete which, in turn, carried a ½-in. cement-sand cushion upon which was bedded creosoted wood block paving, 4 in. thick, selected for its comparatively light weight. Trouble was soon experienced with this pavement. The buckle plates deflected and vibrated under heavy loads, causing a cracking of the lean concrete subbase, displacement of the cushion course and a bulging or "blowing up" of the wood block surfacing over large areas, especially on the main river spans. Water, entering the cushion course during rains or thaws, aggravated the "heaving" of the wood block, especially when followed by freezing weather.

Consequently, during 1915-16, repairs were undertaken to strengthen the floor system without adding materially to its weight. The steel buckle plates were stiffened by riveting 3x3x⅜-in. angle irons across their tops; transverse Z-bars were riveted to the floor beams to prevent the pavement from "creeping;" and 3x12-in. timbers were bolted over the stringers. A thicker and richer 1:2:4 concrete base course was poured and in it ¼-in. grooves were cast to drain all water penetrating the paved surface into 1½-in. weep holes drilled through the bottom of each buckle plate. The deck was then re-paved with wood block only 3 in. thick, instead of the 4-in.

TRUCK-MIXED CONCRETE is delivered to forms for new bridge deck by short inclined chute. In foreground are two vibrating screeds.

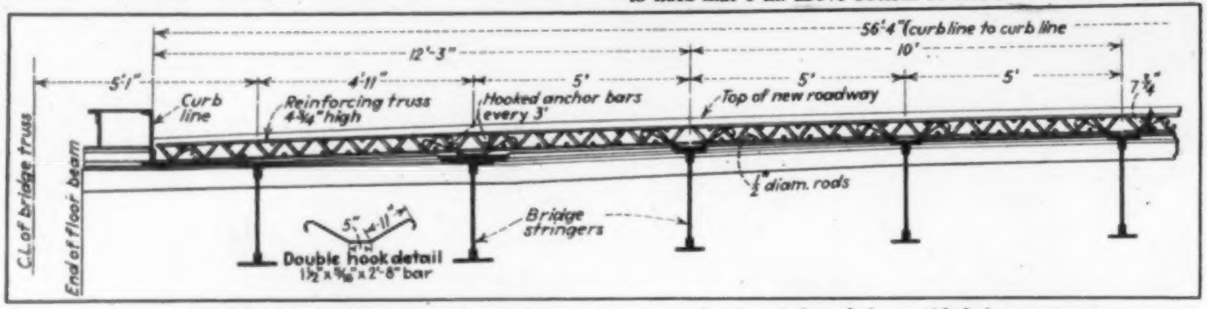
block originally used, and the cushion course was eliminated.

Later repairs involved the replacement of the buckle plate construction along the outer lanes of the bridge roadway ,which carried the heavy truck traffic, with flat steel plates stiffened with transverse $7 \times 3\frac{1}{2} \times \frac{1}{2}$-in. angles riveted to their tops and $5 \times 3\frac{1}{2} \times \frac{1}{2}$-in. angles riveted to tops of plates to add to strength of plate and also to act as restraining angles to keep the wood blocks of the pavement from bulging.

While the foregoing reconstruction measures improved conditions to some extent, the need for periodic repairs to the wood block pavement, with consequent obstruction to the heavy stream of traffic that the bridge carries, still continued, and it was therefore decided to replace the entire floor system and pavement with a more satisfactory, durable, non-skid type of construction.

New Paved Deck—The design, as developed by Isidore Delson, engineer of design, Department of Plant and Structures, provided for two different types of deck for different portions of the bridge structure: (1) A $7\frac{3}{4}$-in. thick concrete slab reinforced with steel bar trusses for the approaches and $7\frac{1}{4}$ in. thick for anchor arm and island spans, where weight reduction was not as important as elsewhere on the structure; and (2) a $3\frac{1}{2}$-in. thick slab, consisting of an armored steel grid filled with concrete, on the cantilever spans over the river channels, where it was of prime importance to reduce the dead load to a minimum. To date, work has been confined to the first type of deck, except for a short test section of the second type.

MAT UNIT of welded bar truss reinforcement is 6 ft. wide and 10 or 12 ft. long. Along edges note raised bar track on which concreting screed rides. At ends, welded vertical strips form projecting "stools" to hold mat 1 in. above bottom of forms.



NEW CONCRETE DECK for bridge roadway $54\frac{1}{2}$ ft. wide is reinforced by welded bar trusses $4\frac{3}{4}$ in. deep, spaced 6 in. apart. Note hooked bars welded to bridge stringers to anchor slabs.

FORM SUPPORTS are 4x6-in. timber cross beams hung from bridge stringers by bolts threaded on lower ends for adjustment.

ALONG EDGES of reinforcing mats are welded longitudinal bars serving as track to carry ends of concreting screeds.

MODEL shows how form panels, with truss reinforcement in place, are carried by beams hung by bolts from bridge stringers.

The concrete slabs $7\frac{3}{4}$ in. thick, now being installed in widths of 12 ft. for the two outer lanes and 10 ft. for the three inner lanes, are reinforced by transverse welded steel bar trusses $4\frac{3}{4}$ in. deep, spaced 6 in. apart on centers, and assembled, for placement, into mats either 10 or 12 ft. long and 6 ft. wide. The upper and lower chords of these reinforcing trusses, supplied by the Kalman (Bethlehem) Steel Corp. and the Concrete Steel Co., are formed by pairs of $\frac{1}{2}$-in. round bars, with a single 7/16-in. bar bent to shape and welded between the other members to form a web with triangular openings. Through the triangular openings in the bar trusses $\frac{1}{2}$-in. longitudinal reinforcing bars are spot-welded to the frames, top and bottom, their spacing varying from $7\frac{1}{2}$ to 14 in. on centers. Details of the concrete slab construction and its reinforcement are shown in a drawing herewith.

It will be noted that to prevent movement of the concrete roadway slabs, due to vibration of the bridge under traffic, $1\frac{1}{2} \times 5/16$-in. hooked bars or "wings" are welded to the tops of the bridge stringers at intervals of 3 ft. and extend upward at an angle of 30 deg. into the concrete to anchor the slab securely to the structural steel of the floor system. Another detail to simplify construction of the concrete slabs is introduced in the form of a $2 \times \frac{1}{4}$-in. bar field-welded along the upper edges of each reinforcement mat to form a track upon which the ends of the screed used to strike off the concrete surface may ride and also to act as a side form for a white cement traffic guide line. Then, too, in order to provide for a 1-in. thickness of concrete between the lower chords of the reinforcing trusses and the bottom of the slab vertical legs or "stools" of $1 \times \frac{1}{4}$-in. steel, are welded to the ends of the mats at 3-ft. intervals so as to rest on the bridge stringers, to which they are welded, and hold the mats 1 in. above the bottom forms for the slab.

Comparative Unit Weights — The deck of the Queensboro bridge as originally built with steel buckle plates, concrete base and wood block paving, weighed approximately 65 lb. per square foot of surface. The unit weights of the new reinforced concrete deck slabs are as follows: For $7\frac{3}{4}$-in. thick slabs on approaches, including welded bar truss reinforcement, 108 lb. per square foot; for $7\frac{1}{4}$-in. thick reinforced slabs on anchor arm spans, 100 lb. per square foot; for $3\frac{1}{2}$-in. thick armored grid slabs (including curb) on cantilever spans over

river channel, 56½ lb. per square foot. There is no particular disadvantage in the somewhat greater weight of the new deck on the approaches and anchor arm spans of the bridge. On the cantilever spans, however, it was necessary in the new floor design to keep the dead load to a minimum — hence the thinner 3½-in. armored grid type of construction.

Sequence of Operations — Since the Queensboro bridge, carrying about 36,000,000 vehicles per year, constitutes the sole trafficway between Manhattan and Queens (pending the completion of the new Triborough bridge) reconstruction of the deck had to be planned for execution on a piecemeal basis of one 10-ft. or 12-ft. lane at a time, so as not to put out of service more than one lane of traffic at a time. The principal operations involved in the reconstruction work, as illustrated in the accompanying photographs, are, in sequence:

(1) *Removing old wood block pavement.*
(2) *Burning out old steel buckle plates and stiffened flat plates of bridge floor system with oxy-acetylene torch.*
(3) *Setting forms between stringers for new concrete deck slab.*
(4) *Placing mats of steel bar truss reinforcement and wiring splice bars between them.*
(5) *Welding stools of reinforc-mats to bridge stringers.*
(6) *Welding hooked bar anchors to stringers to hold concrete slab in place.*
(7) *Pouring concrete into forms from truck mixers.*
(8) *Finishing and mechanically vibrating concrete.*
(9) *Curing concrete with asphaltic spray.*

TWO VIBRATING SCREEDS, in tandem, consolidate concrete and finish surface of new roadway on Queensboro bridge.

BAR TRUSSES are placed in mat units, spliced at ends with longitudinal bars. Note hooked bar anchorages for slab welded to bridge stringers at 3-ft. intervals.

LEVELING SCREED is pulled by hand across surface of concrete prior to passage of vibrating screeds.

OLD FLOOR SUPPORT *(below)* of two types: (1) Stiffened flat plates, in foreground; (2) Buckle plates, in upper right corner.

COMPLETED OUTER LANE of new concrete roadway extends alongside section of old wood block pavement carrying heavy traffic.

BULLET TYPE VIBRATOR *(below)* helps pack concrete between steel bar reinforcing trusses of new bridge deck.

The order of work for repaving the deck of the bridge and its approaches is: (1) Queens approach and anchor arm span; (2) Welfare Island span; (3) Manhattan anchor arm span; (4) Two cantilever spans over East River.

Work was begun on the northerly traffic lane of the approach to the bridge from Long Island City and continued toward the Manhattan side after the old wood block paving and its concrete base had been removed with the aid of hand picks and pneumatic paving breakers served by a single compressor from the Manhattan end of the bridge. The steel plates of the original floor system are cut out with oxy-acetylene torches and removed, exposing the stringers and floor beams of the bridge. In the opening between the stringers a wooden working platform is hung to aid in setting the forms for the concrete deck slab. The forms themselves, in panels to fit the openings, maximum size 1½x8 ft., lined with ⅝-in. plywood, are blocked up from 4x6-in. wooden cross-beams hung from ¾-in. bolts extending through holes drilled in the top flanges of the bridge stringers, as illustrated. These bolts are threaded on their lower ends and are fitted with nuts so as to facilitate a nice vertical adjustment of the form.

With forms set, the prefabricated steel truss reinforcing mats are placed in 6x12-ft. or 6x10-ft. units (depending on the width of the lane being concreted) and spliced with 3½-ft. longitudinal ½-in. bars at joints. Hooked bars are then welded to the bridge stringers at intervals of 3 ft. to anchor the completed slab against movement under vibration caused by traffic.

Concreting — Concreting is done with truck-mixers delivering through short inclined chutes to the forms. The mix is 1:1½:3¼, using a ¾-in. trap rock for the coarse aggregate and Incor highly-early-strength cement, as it was essential, because of the heavy traffic the bridge carries, to get the completed portion of each repaved traffic lane back into service as soon as possible after concreting. The water-cement ratio of the mix is less than 5 gal. of water per bag of cement and the slump is 3 in. As thus mixed, and placed, the concrete develops a strength of from 4,000 to 6,000 lb. per square inch after 7 days. Because of the limited working space available on the bridge, with traffic passing in a continuous stream in adjacent lanes, it would have been difficult, if not impossible, to employ a standard paving mixer on the bridge floor. Delivery of mixed concrete in 4-yd. batches in the trucks of the Colonial Sand & Stone Co. simplified the concreting problem, eliminated heavy mixing equipment in the congested working space available and offered a minimum of obstruction to traffic using the open lanes of the bridge.

VIBRATION of concrete on Williamsburg bridge is done with screed carrying three vibration units to serve 18-ft. 3-in. wide roadway. In foreground is one of bullet type vibrators.

J. FRANK JOHNSON *(left)* engineer in charge of Williamsburg bridge.

CONCRETE VIBRATION on Williamsburg bridge new roadway being done, first, with three types of internal machine, to be followed by surface vibration with screed.

Vibration — Because of the large amount of reinforcement in the deck slab it was necessary to insure the flow of concrete completely around and through the steel reinforcing trusses and prevent honeycombing by the use of a pair of internal vibrators of the Chicago Pneumatic Tool Co.'s "bullet" type. Using air at 80 to 90 lb. pressure these units operate at frequencies of 6,000 per minute in consolidating the concrete.

After the concrete is thus poured, spread by hand shoveling, and vibrated internally it is screeded by a heavy, 9-in. bulb angle which is pulled by hand along the angle-iron tracks previously referred to, in order to level off the surface ¾ in. above its final grade. Then the pavement is finished by a pair of Munsell vibrating surface screed boards, in tandem, consisting of 10-in. channels each carrying two air-operated vibrator elements located at the one-third points of the channel length; these vibrators, using air at 80 to 90 lb. pressure, run at frequencies of about 5,000 per minute. After the passage of the second vibrating screed board the finished concrete surface is broomed and cured by the Hunt process involving the application of a bituminous spray to both the top and bottom surfaces of the slab after the forms have been stripped.

To mark the five traffic lanes on the reconstructed bridge deck a 6-in. wide guide-line of white cement is cast as an integral part of the paved surface.

Williamsburg Bridge — The work on the Williamsburg bridge, a cable suspension structure with a main span of 1,600 ft. and a total length, including approaches, of 7,308 ft., which has been in service since 1903, involves the construction of an additional two-lane, 18 ft. 3-in. wide roadway along an area formerly occupied by street railway tracks, which have been abandoned. Construction is, in general, similar to that on the Queensboro bridge except that, on the approach spans, the new concrete slab is 6¾ in. thick and is reinforced by welded steel bar trusses 4¾ in. high, spaced 6 in. on centers. As the areas occupied by the new roadway carried no motor traffic full-width slab construction, with both internal and surface vibration of the concrete with Munsell air-operated machines is possible after two new stringers are added to strengthen the floor system of the bridge under each new roadway. Truck mixers deliver 1:1½:3¼ concrete using high-early-strength cement and coarse aggregate of ¾-in. trap rock; 5.8 gal. of water is added for each sack of cement; the slump of the mix is 4-5 in.

Forms are lined with ¾-in. plywood and are hung from the bridge stringers by wire saddles supporting 2x6-in. timber cross beams. Because of the greater width of roadway concreted in one operation on the Williamsburg bridge the surface vibrating screeds are equipped with three, instead of two, vibrator elements.

The repaving of both bridges will provide quicker and safer passage for the heavy flow of motor traffic that crosses the East River between Manhattan and the boroughs of Queens and Brooklyn and will also lower the cost of bridge maintenance by the Department of Plant and Structures of the City of New York.

Road Builders' Plight

By D. V. PURINGTON, *Palestine, Texas*

IN THE PUBLIC MIND there is an old and widespread fallacy that anyone with a strong back can dig a ditch — in spite of the evidence presented under the CWA. Men of the highway industry have had bitter experience with it.

Generally speaking, a highway is a hard-surfaced embankment between two parallel ditches, and throughout the years numerous individuals have attempted to put the old ditch-digging idea to work only to discover to their sorrow that it would not work. The records show that the average life of contracting organizations is about 7 years, and although the list of annual failures in the road-building industry is not available, it must be fairly long.

In spite of these tragedies this industry grew from comparative insignificance in 1904 to tremendous magnitude in 1929 and 1930. Spurred by the automobile builders, the road-building industry was much in the public mind when the first waves of the financial crash broke. Immediately, the old idea blossomed that anyone could dig a ditch or build a road. Generous allotments were made throughout the country for road-building and, in view of the ditch-digging theory, contractors had to select as many employees as possible from among unemployed local citizens.

Looking back we find some ambiguity in the plea for local labor at that time. For the most part, depression unemployment was being felt most severely in the cities and manufacturing centers where streets and roads were already in a fairly high state of development. It was in the rural areas, however, that the bulk of the allotments were spent. Market conditions were poor, but it was only with the idea of supplementing their incomes that the farmers and farm labor took up the opportunity of road building. They, too, believed in the ditch-digging theory and learned a costly lesson when they attempted to subcontract a part of the road construction within their neighborhoods.

The established road contractors, however, were fully aware of the ditch-digging fallacy, and avoided a too hearty compliance with the request to employ local citizens. They realized that they could not afford to pay experienced wage rates for inexperienced help and, with the growth and increase of unemployment, their labor supply markets became gutted with eager applicants for work. Men called them at all hours, besieged their offices and their homes and asked for jobs at any price.

Thus the wages on highway construction began to break, not through any fault of the contractors, but because these job-hungry applicants were beating them down. At this point, the state and Federal governments took a hand by establishing a minimum wage scale for common labor in all of their contracts. Unfortunately, the need for haste was great, and the most expedient procedure appeared to be the establishment of this minimum wage scale on a basis of the average wage paid for common labor within certain areas before the depression had started. There was no time for more detailed studies — the average wage basis would have to stand.

The Minimum Wage — Theoretically, the establishment of a minimum wage is an excellent thing, but when it is done so hastily and so arbitrarily it takes on the same flavor that the Stamp Tax and the Tea Tax had during the Revolution. Its action is similar to that of the slot machine or the punch board devices wherein the operator puts in a certain amount and receives an unpredictable amount in return. No normal person building his own house would hand over a given amount of money to a contractor without having some knowledge of how large a house he was to receive in return. Yet that is what occurs under the present minimum wage laws.

It is true that the laws prescribe for the wage so many hours per day and that the amount paid shall be full compensation for a day's work. But what constitutes a day's work? There's the rub! Shall it be 4 or 14 yd. of gravel moved in one day? Individuals vary in size and strength and energy, but the law does not mention the amount of work they should do; it only specifies the time to be spent on the job.

This payment for hours of time is a very old custom, but its age does not guarantee its perfection nor its perpetuity. There has been a gradual growth of the method of rewarding individual performance on a piecework basis, which has been notably successful in the automobile and other forward looking industries.

The piecework method of wage payments was gradually developing in highway construction before the fever of regulation broke out and replaced it with a minimum wage rate so high that it has practically become both minimum and maximum. When a minimum wage scale is set by arbitrary decision, without the basis of proper investigation, it becomes a burden on the employer, if it is set too high, and a source of dissatisfaction to the employee, if it is too low. So far, there has been very little evidence of dissatisfaction on the part of the employees on highway construction, but there has been a considerable burden on the contractors. And this burden has not been lessened by the tendency among some of the labor to do as little work as possible in return for this guaranteed minimum wage.

Labor Regulations — Following the minimum wage regulation came the requirements that local labor be employed wherever possible. It was the same old ditch-digging fallacy again, and the wise contractors, who recognized it, found that the possibility of employing much local labor was rather small. But when the NRA came into being with its stringent labor regulations and 30-hr. week there was little opportunity of choice. The local relief employment authority sent men out to the job and the contractor employed them. No man, except a foreman, was allowed on a job unless he presented a card from the local authority stating that he was a bona fide citizen and entitled to work.

This regulation may have had justification in the suburban areas, where a number of skilled mechanics and workmen were unemployed, but in the rural areas it worked hardships both on the contractors and on the workmen. When the contractors requested skilled operators for heavy machinery there was none to be had, and the local labor authorities would offer, as substitutes, men whose experience had been confined to driving light trucks or farm tractors. The losses in production and mechanical breakdowns due to these unqualified operators was so great that the regulations were changed within the year.

Before the change there was little opportunity for a skilled mechanic outside of his home county, and unless there was work within the county in which he was a legal resident he could not get work at his trade until all of the possible men were exhausted and the local labor authorities were willing to request his transfer to the work in their district. This condition still exists on Federal work, and as a result the mechanic whose home is in an industrial center is barred from seeking work away from home unless there are no other men available. He must secure a request from the contractor in order to obtain a transfer.

Whenever allowed, there is more machinery being used on highway construction work than there was before the depression, mainly because the labor regulations have shown that it is cheaper to use it than to expect to make any profit on the unqualified and inexperienced labor furnished. It has been estimated that the labor cost of construction has been increased almost 25 per cent by the requirements that local labor must be used.

A Trade Wiped Out — Not only have these regulations affected contractors and construction costs, but they have practically wiped out a trade class that has been developing since the first days of railroad construction. While the highway builders were gathered from all types and races, they did not "ride the rods" and haunt the bunk cars — they had their automobiles, their tents and trailers and their families. From here and there the contractors had picked them and had carried them along whenever jobs were plentiful. Youngsters who were quick to learn and made good hands were always welcome in the organization. After a few years they found jobs as foremen and built up their own loyal gangs which could move ahead to prepare the plant for the next job, or be left behind to do the cleaning up, without a slip.

But when the Blue Eagle hatched and left the nest, these groups were torn apart and left stranded in strange territories. Because they had followed their jobs and lived on them, wherever they happened to be, many of these men had no legal residence. They had grown up with their jobs, moving about the country often from state to state, and when the rules were laid down that no one but legal residents of the political subdivisions should be employed on the highway work, they were cut off and left, in many cases, to become wards of the counties while men who knew nothing about their work and cared less took their places.

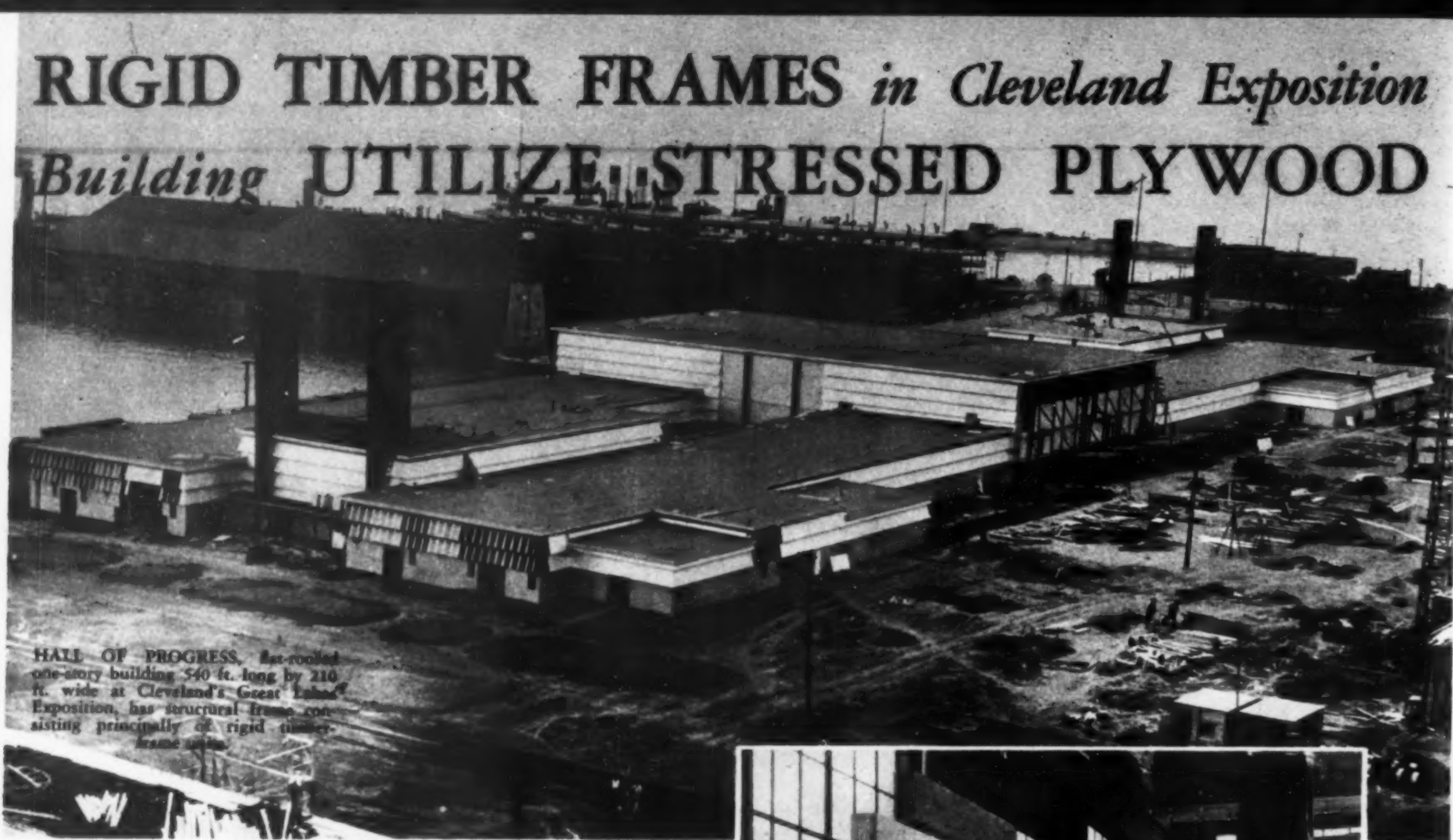
Under the regulations which exist today there is no possibility of developing an experienced construction crew. The highway projects are usually too short to permit the contractor to benefit or the men to learn, and there is little chance that there will be sufficient continuous work in one county to allow the development of experienced men into qualified foremen.

A few of the old experienced men have survived and been promoted to foremanship in order to preserve their knowledge of the work, but only a few can really qualify to direct this new type of conscripted labor. It takes a high type of skill and social knowledge to be able to direct these new men and to secure a profitable amount of work from them, a skill which many of the older type of foreman does not have.

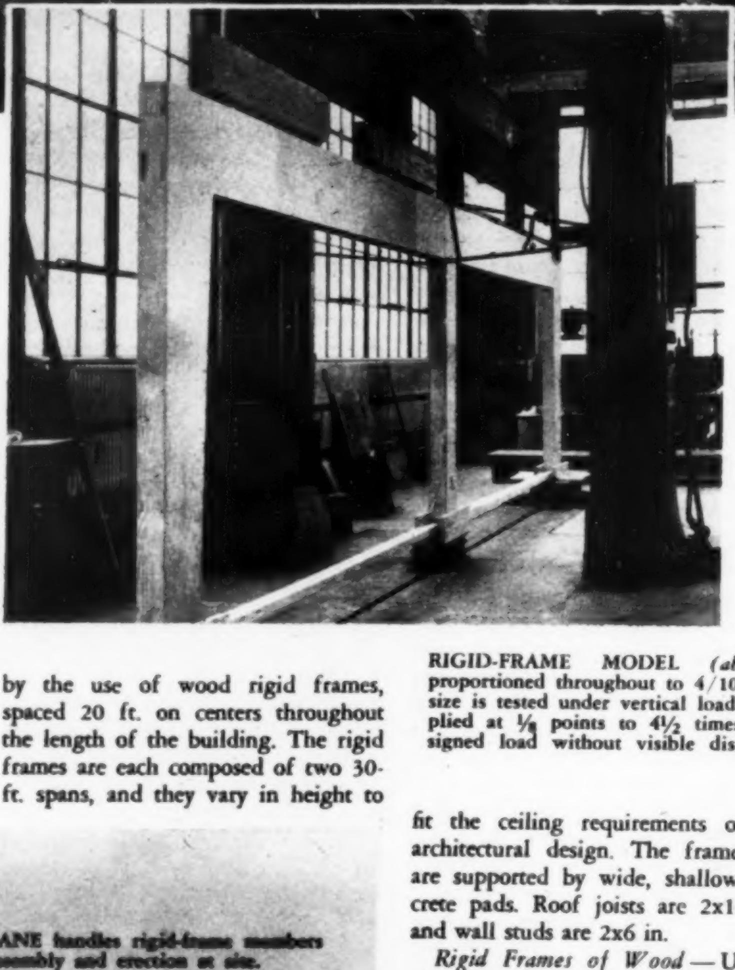
The genuine gay camaradarie that used to be prevalent on construction jobs is gone. The greetings, loyalty and good fellowship that grew from years of working together, bumming together, and fighting together, have practically disappeared and in their places is a sullen spirit of suspicion and unrest. Men work side by side as comparative strangers, with no incentive to strike up ties of friendship or to push themselves ahead for the sake of a better job. There is no loyalty or pride in workmanship — it's not their job. There is no permanence — a few dollars for a few hours is all they can expect.

So what's the use!

RIGID TIMBER FRAMES *in Cleveland Exposition Building* UTILIZE STRESSED PLYWOOD



HALL OF PROGRESS, flat-roofed one-story building 540 ft. long by 210 ft. wide at Cleveland's Great Lakes Exposition, has structural frame consisting principally of rigid timber-frame units.



RIGID-FRAME MODEL *(above)* proportioned throughout to 4/10 full size is tested under vertical loads applied at ⅛ points to 4½ times designed load without visible distress.

By C. MERRILL BARBER

Structural Engineer, Cleveland, Ohio.

RIGID TIMBER FRAMES made up of nailed box-section columns and girders utilizing plywood as cover-plate material provide the structural backbone of the Hall of Progress, 540 ft. long by 210 ft. wide, at Cleveland's Great Lakes Exposition. Each rigid frame comprises three columns spaced 30 ft., c. to c., and a rigidly attached top member about 60 ft. long. The rigid frames were fabricated at the site in three heights: 16 ft., 18 ft. and 32 ft. Simple columns and girders of plywood construction, fabricated in T-units to simplify erection, fill the gaps between rigid frames.

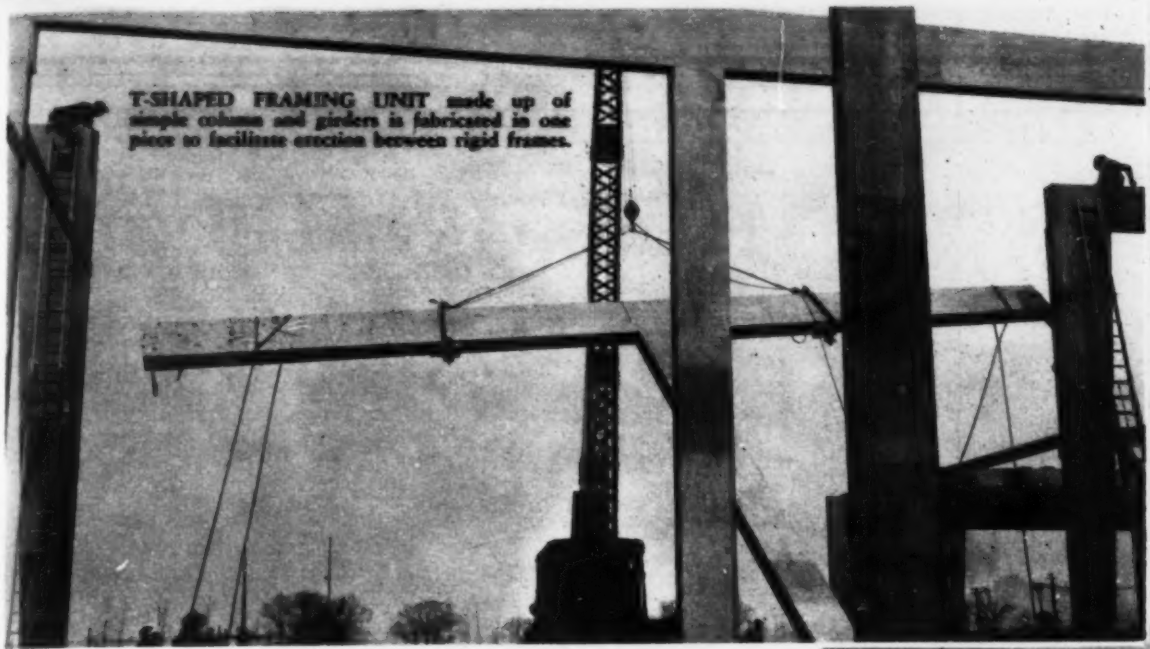
Design Problems—Design and construction of a one-story building of about 100,000 sq. ft. floor area for the Great Lakes Exposition had to meet some definite limitations. To begin with, the exposed location directly on the shore of Lake Erie of the Hall of Progress promised a substantial sweep of wind against which adequate provision had to be made. Second, the structure had to be built at low cost to fit within the modest budget of the Exposition. Third, the site was on filled ground which precluded any heavy concentrations of load. Finally, the time for construction was short — with the opening date set for June 27 — scarcely three months away.

As the architectural solution of the problem, Hays & Simpson, Cleveland architects, designed a building 210 ft. by 540 ft., composed of two long units 60 ft. by 540 ft., connected at both ends and center with structures 24 and 32 ft. in height. The roof is flat and the exterior wall treated with continuous horizontal screened louvres.

A structural solution was achieved by the use of wood rigid frames, spaced 20 ft. on centers throughout the length of the building. The rigid frames are each composed of two 30-ft. spans, and they vary in height to fit the ceiling requirements of the architectural design. The frame legs are supported by wide, shallow concrete pads. Roof joists are 2x10 in., and wall studs are 2x6 in.

CRAWLER CRANE handles rigid-frame members during assembly and erection at site.

Rigid Frames of Wood — Use of rigid frames in bridges and buildings is of quite recent date. For many years reinforced-concrete structures have shown unusual strength at certain points and also surprising weakness at other points, caused mainly by the fact that the finished building has acted as a homogeneous unit and followed the stress distribution principles of such a structure rather than those of simple beams, girders and columns. The economy of continuous slabs, beams and girders has long been recognized, but because of the complex



T-SHAPED FRAMING UNIT made up of simple columns and girders is fabricated in one piece to facilitate erection between rigid frames.

mathematical calculations involved there has been little effort to extend this economy of continuity into columns of buildings. Bridge engineers have been particularly interested in this field and have recently designed and built in both concrete and steel several bridges of real beauty at a considerable saving in cost.

The possibility of using in the Hall of Progress a few units of a repetitive nature convinced the writer of the feasibility of designing rigid frames of wood. A preliminary design was made, utilizing a light framework of standard 2x6-in. and 2x10-in. members, covered on the exterior with ⅜-in. plywood. Through the cooperation of Case School of Applied Science, and Prof. Fred L. Plummer of the Civil Engineering Department, who was retained by the Great Lakes Exposition to check the structural design, two seniors took as their thesis the testing of models of the frame design.

Models Tested — The top member of one-half of the frame was tested in wood at one-half full size. This model was assembled partially by nailing and partially by gluing, then tested to destruction. It was decided for practical assembly in the field to develop all joints by nailing, and thus eliminate the necessity of gluing or special bolting details.

A model of a complete low rigid frame was constructed of wood at 4/10 full size, this scale being selected as utilizing ordinary ¼-in. commercial plywood. All framing members were proportionately reduced and the nailing carefully computed. The frame was set up and vertical loads applied at the ⅛ points. The frame was loaded with an equivalent of 4½ times the design load with no visible distress. At this point the frame buckled sideways, provision to resist this buckling being impossible in the laboratory.

A complete model of the highest rigid frame was built in celluloid at 1/12 full size. Upon this model both vertical and horizontal loads were placed. An attempt was made on this model to reduce the depth of the exterior legs from that of the preliminary design. However, undue horizontal deflections necessitated the return to the first design.

TIMBER FRAMES are fabricated by carpenters at site in accordance with nailing layout designed to develop strength of plywood joints.

Hall of Progress — The Hall of Progress uses three sizes of rigid frames, all of two 30-ft. spans and 16, 18 and 32 ft. in height. Each of these frames was completely detailed, and an accurate nailing layout made for one typical frame. Especial care was taken to develop plywood joints, as the plywood becomes a homogeneous part as the stressed covering of the frame.

The horizontal top member of the rigid frame is composed of five 2x10-in. timbers, two set on edge at the bottom of the member and two on edge surmounted by one flat at the top to form a nailing surface for roof joists. The 2x10-in. pieces are separated by 2x6-in. diagonals set on edge and running at approximately 45 deg. The top member varies in depth from 3 ft. 3 in. to 2 ft. 8 in. to provide for roof pitch, the bottom of the member being level.

Exterior leg members are likewise composed of four 2x10-in. timbers, two pieces set in the same plane as those of the top member and two perpendicular to this plane in order to give a finished box column at the frame ends. The exterior legs taper from 2 ft. in depth at the base to 3 ft. for the 16-ft. frames and 4 ft. for the 32-ft. frames at the intersection with the top member. The center column has four 2x10-in. timbers, set perpendicular to the face of the frame. All vertical members have diagonals the same as the top member. The center columns have a constant depth of 2 ft. for the low frames and 2 ft. 6 in. for the high frames. All diagonals and chord members are No. 1 Yellow Pine and are assembled with 10d coated nails.

Sides and edges of all members are covered with ⅜-in., five-ply Douglas fir plywood, manufactured with waterproof glue by the cold process. All plywood is applied with 6d coated nails. The total thickness of all frames is a constant, 10¾ in.

The rigid frames were designed by the slope deflection method, consideration being given to both a fixed and hinged condition at the bottom of the legs. All frames are designed to carry dead, live and wind loads, and were assembled by carpenters at the site of the building, exposed to rain and freezing. After assembly and complete nailing the frames were lifted into place by a small motor crane. Simple span girders and columns between the frames were assembled as large T-members to facilitate erection. In all, 52 wood rigid frames, 34 built-up girders and 22 simple columns were completely assembled and erected in 10 working days.

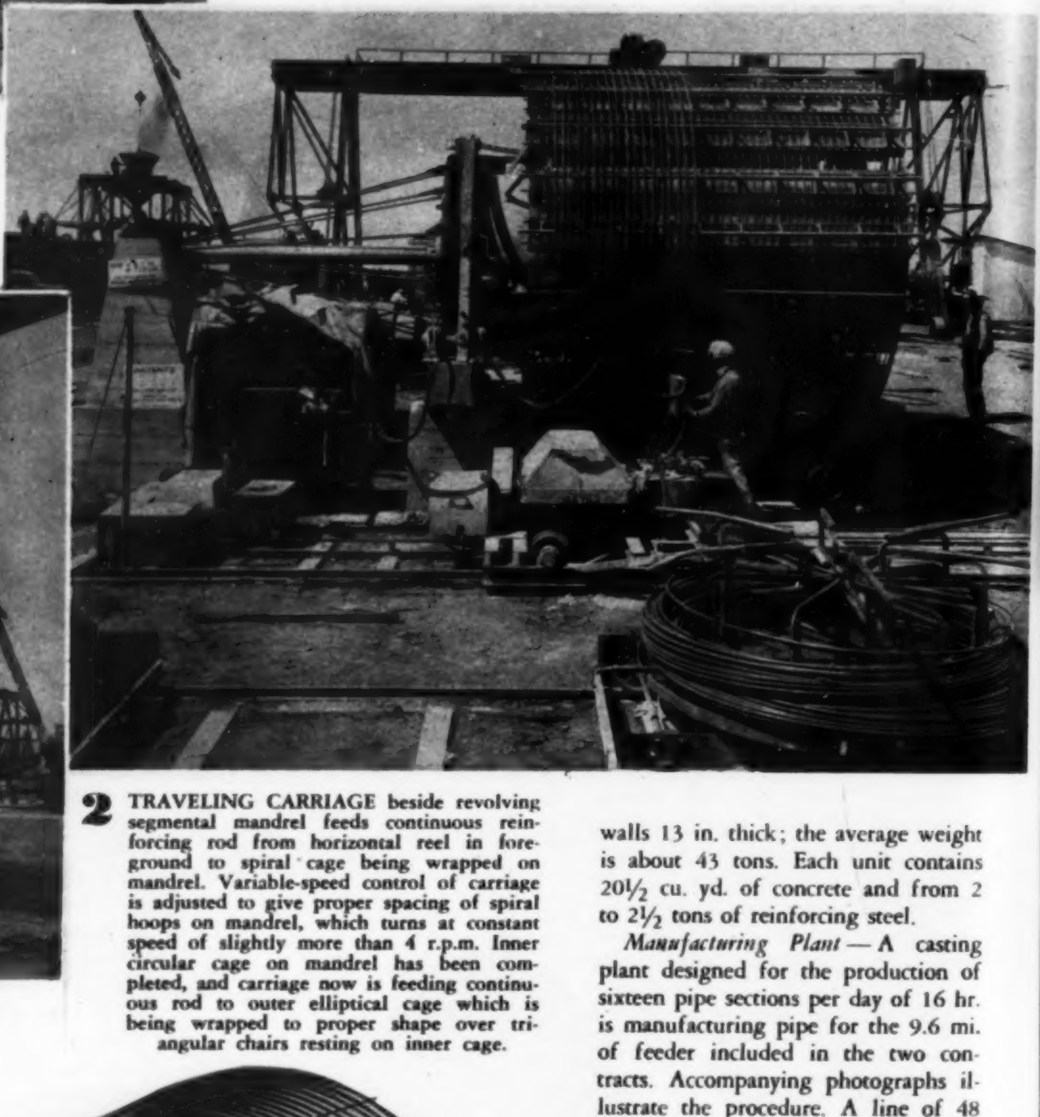
In the completed structure the wood rigid frames present a neat, finished appearance, giving the observer a feeling of pleasing and harmonious proportions with a sense of comfortable stability. In line with the doctrine that "form follows function", it is felt that the rigid frames carry out this maxim. The Hunkin-Conkey Construction Co., Cleveland, was the general contractor for the building.

RIGID FRAMES *(below)* of nailed box-section members incorporating 2x10-in. timbers covered with ⅜-in. five-ply plywood furnish structural skeleton for huge building containing 100,000 sq.ft. of floor area.

Step-by-Step Field Methods

Precasting and Placing 43-Ton Sections of 12-Ft. 8-In. Pipe

1 BASE RINGS for vertical casting of 12-ft. pipe sections with inside diameter of 12 ft. 8 in. are fabricated by welding together steel plates and shapes and then machining all surfaces which come in contact with concrete or with inside or outside form jackets. Bottom rings are fastened by anchor bolts to concrete foundations. Base rings and forms are made with tolerance of only 1/32 in. in diameters.

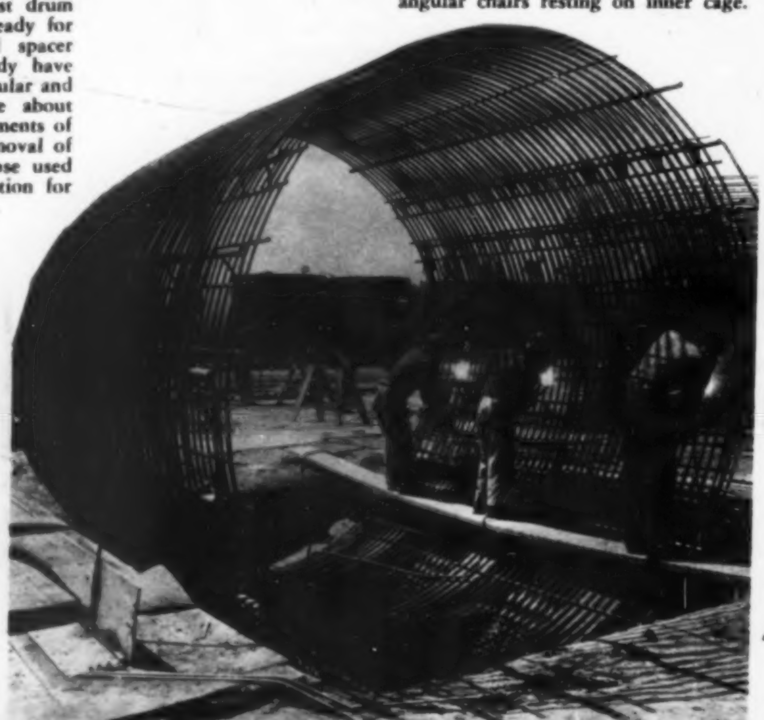


2 TRAVELING CARRIAGE beside revolving segmental mandrel feeds continuous reinforcing rod from horizontal reel in foreground to spiral cage being wrapped on mandrel. Variable-speed control of carriage is adjusted to give proper spacing of spiral hoops on mandrel, which turns at constant speed of slightly more than 4 r.p.m. Inner circular cage on mandrel has been completed, and carriage now is feeding continuous rod to outer elliptical cage which is being wrapped to proper shape over triangular chairs resting on inner cage.

3 PICKED UP *(above)* by gantry in two canvas slings and pulled off mandrel by hauling rope which leads to small air hoist drum (not visible), reinforcing cage is ready for welding of additional longitudinal spacer bars. Four longitudinal bars already have been spot-welded to two spirals (circular and elliptical) where these cages have about same diameter. Seven adjustable segments of mandrel are collapsed to permit removal of cage by deflating lengths of fire hose used in forcing these segments into position for original wrapping operation.

SPECIAL EQUIPMENT and methods developed by the American Concrete & Steel Pipe Co., Los Angeles, contractor, are producing and placing in two contract sections of the main feeder between Cajalco reservoir and Pasadena's Pine Canyon dam in the distribution system of the Metropolitan Water District of Southern California precast pipe sections of 12-ft. 8-in. inside diameter — the largest precast concrete pipe of record. The sections are 12 ft. long and have walls 13 in. thick; the average weight is about 43 tons. Each unit contains 20½ cu. yd. of concrete and from 2 to 2½ tons of reinforcing steel.

Manufacturing Plant — A casting plant designed for the production of sixteen pipe sections per day of 16 hr. is manufacturing pipe for the 9.6 mi. of feeder included in the two contracts. Accompanying photographs illustrate the procedure. A line of 48 fabricated steel bottom rings set on permanent concrete bases extends about equal distances in two directions from a central mixing plant with a locomotive crane track and an industrial railway track running parallel with the line of base rings between them and the mixing plant. A traveling gantry

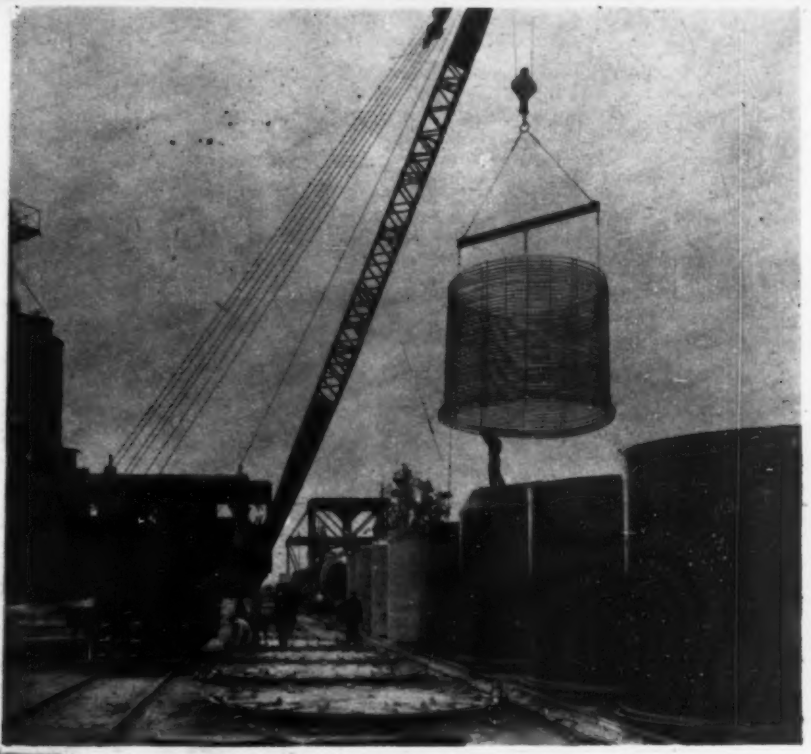


4 REINFORCING CAGE *(left)* upon removal from mandrel is placed in shallow pit on rubber belts which are wound by electric motor to turn cage, permitting three welders on stationary plank to tack-weld longitudinal bars around entire circumference of spiral hoops without changing working positions. Shielded-arc process, using coated electrodes, is employed for all welding operations. As welds are for tacking purposes only, officially qualified welders are not required.

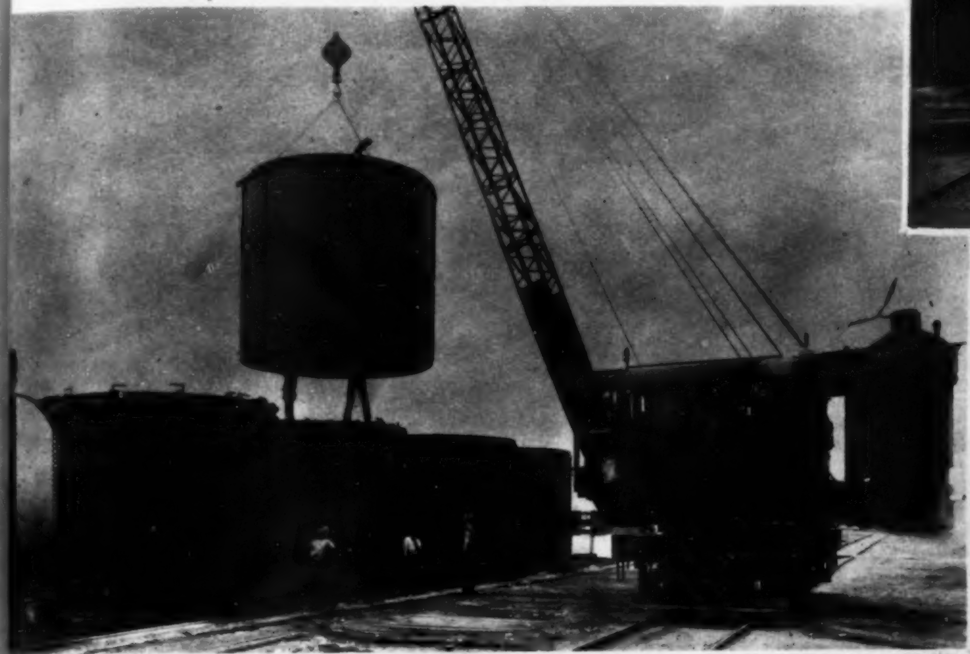
rig for placing concrete and handling pipe sections spans the line of base rings.

Pipe Reinforcement — Reinforcing steel ranges in size from 1/2 in. round to 3/4 in. round bars in increments of 1/16 in. About 1/3 of the steel is placed in an inner circular cage and 2/3 in an outer elliptical cage, the amount of steel varying in accordance with external loads on the pipe. The steel bars are wrapped in continuous spiral hoops on a revolving cantilevered drum made up in part of segments which can be expanded and retracted. Lincoln portable generators are used to weld a total of 22 1/4x1 1/2 in. longitudinal spacer bars to the hoops.

Concrete Design — Concrete for the pipe contains 6 3/4 packs of cement per cubic yard. Aggregates include sand, fine gravel (1/4 to 1/2 in.), and coarse gravel (1/2 to 1 1/8 in.). Bulk cement is delivered by railroad, stored in an 1,800-bbl. bin at ground level and elevated to a smaller bin above the mixer. Dry materials are batched by weight



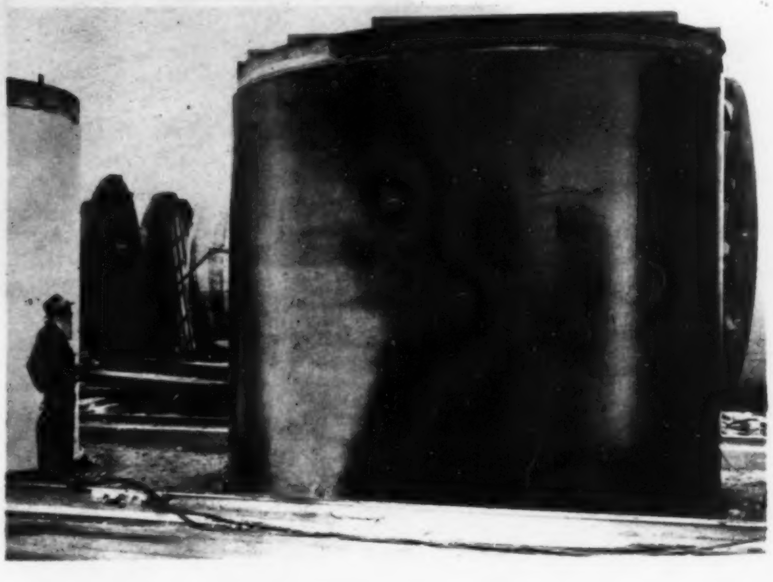
5 AFTER OILED INNER JACKETS have been placed on base rings, locomotive crane lowers reinforcing cages into position. Inner form is made of 5/16-in. steel plate with small collapsible section which permits form to be contracted 2 3/4 in. to facilitate removal. Note additional reinforcement consisting of three hoops of 7/8-in. round bars in bell (lower) end of cage.



6 OVER CAGE OF REINFORCING BARS locomotive crane places outer form consisting of single steel plate, stiffened with vertical ribs, having one bolted joint. Inner form carries working platform, on which men are standing, and top ring which holds inner and outer jackets circular and concentric.

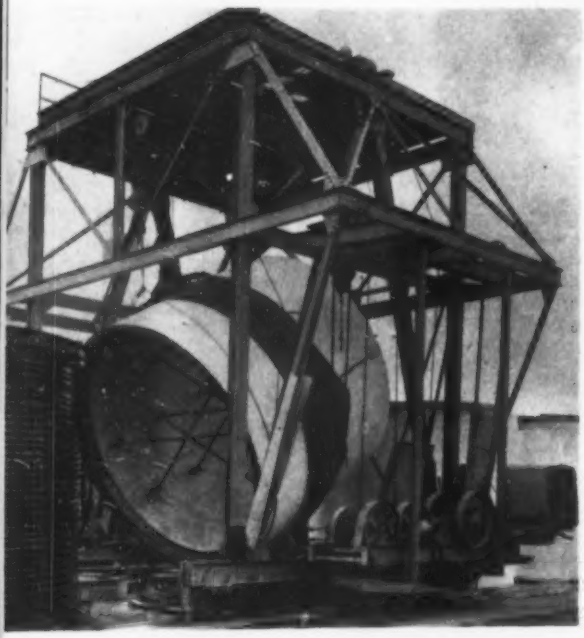
8 CONCRETE from 4-yd. mixer in plant at left is delivered in 2-yd. hoppers by industrial railway to locomotive crane which places batch in gantry-mounted hopper equipped with swivel spout above pipe forms. Train has capacity of three hoppers, returning to mixer with two empty buckets while crane handles third. Each bucket-load adds about 1 ft. to depth of concrete in 13-in.-thick walls of pipe. Three external vibrators operate against outside form during placement of concrete.

7 TO ELIMINATE AIR AND WATER POCKETS and reduce surface defects in concrete, crew of five trained men operate internal rotating rods along inside and outside form surfaces. Each rod is 14-ft. length of 1/2-in. square reinforcing bar, with offsets welded on at intervals, rotated at about 700 r.p.m. by small air motor. Agitation by rotating rods is carried on for about 20 min. in each pipe.



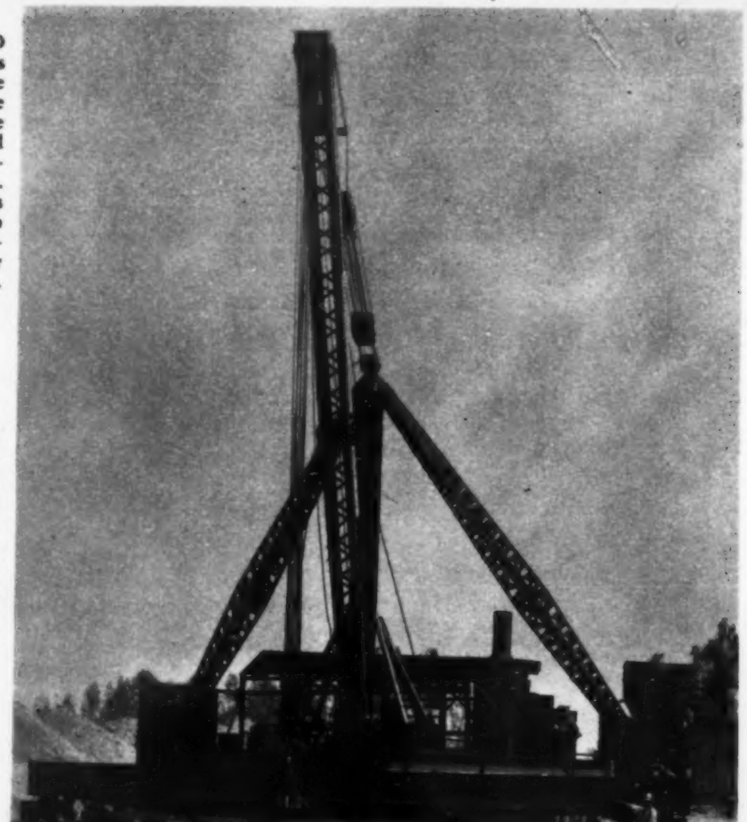
9 ON FOLLOWING MORNING *(left)*, 12 to 16 hr. after completion of concrete placement, inner and outer forms are removed, and outside of pipe is given two spray coats of cut-back coal tar, followed by coat of whitewash to reduce heat absorption. During first 5 to 8 hr. after concreting, interior of inner form is heated by steam from underground pipe, raising temperature of outer form to about 100 deg. F. and developing early strength in concrete. Pipe remains on base ring for 3 days. After forms are stripped, top is covered and inside is kept wet by water sprays from underground pipe.

10 AT END OF 3 DAYS *(below)* pipe is turned into horizontal position after three sets of tubular braces have been installed inside and tightened against wood blocks by trench jacks. Special steel yoke designed to exert uniform pressure proportional to lifting force around entire circumference of pipe is used in conjunction with same gantry which places concrete to turn 43-ton section. Ordinarily gantry merely turns pipe on to wood blocking between rails, from which pipe is rolled into adjacent curing row. Pipe ends are covered and interior is kept wet by automatic intermittent water sprays during remainder of 14-day curing period.



11 FROM CURING YARD at end of 14 days pipe is rolled by hauling cable on to low-bed trailer, care being taken to turn pipe on rolls on trailer until it is in position for placing directly in trench. Truck and trailer units haul 43-ton loads at 8 to 10 m.p.h. over construction road maintained by contractor on right-of-way.

12 INTO TRENCH *(right)* with steep banks, excavated short distance ahead of pipe by dragline, steel stiff-leg derrick straddling cut lifts 43-ton pipe section and places it on subgrade. Pipe section is drawn into contact longitudinally by ratchet puller anchored inside laid pipe.



using cumulative scales with automatic photo-electric cell control and mechanical interlocks to insure accuracy. Water is metered to give the concrete a slump of 4 to 5 in. A 4-yd. mixer in the plant discharges into 2-yd. buckets on an industrial train. The plant produces 325 cu. yd. per day.

Specifications provide that pipe cannot be turned from vertical position for 72 hr. after casting, but the forms may be stripped on the morning following the placing of concrete. Thus it is necessary to have 48 form bases but only 16 complete sets of forms. The first shift in the morning strips forms from 14-hr. old pipes and re-erects them for the next set of pipe sections, which are filled by the second shift.

Administration — For the Metropolitan Water District of Southern California, F. E. Weymouth is chief engineer and general manager, R. B. Diemer is engineer in charge of the distribution system, and H. R. Bolton is construction engineer. Operations of the American Concrete & Steel Pipe Co., Los Angeles, are under the direction of H. H. Jenkins, vice-president. Don Rankin is superintendent at the manufacturing plant, and Jap Connell is job superintendent.

13 TRAVELING HOPPER *(left)* on top of pipe delivers concrete through pipe spouts down two sides of pipe to make continuous supporting cradle under newly laid sections prior to mortaring of joints. Paving mixer handles concrete on long boom to rolling hopper. Pipe cradle extends through central angle of 100 to 180 deg. depending on external loading; trench depth varies from 18 to 28 ft. First cement mortar joint filling, centrally located within circumferential joint, is placed immediately through orifice provided in top of pipe and is rodded with flexible cable. Second calking of joint, made from inside pipe by pointing cement-mortar into open groove, awaits completion of backfilling, final settlement of pipe and development of uniform temperature.

JOB ODDITIES

A MONTHLY PAGE OF

Unusual Features of Construction

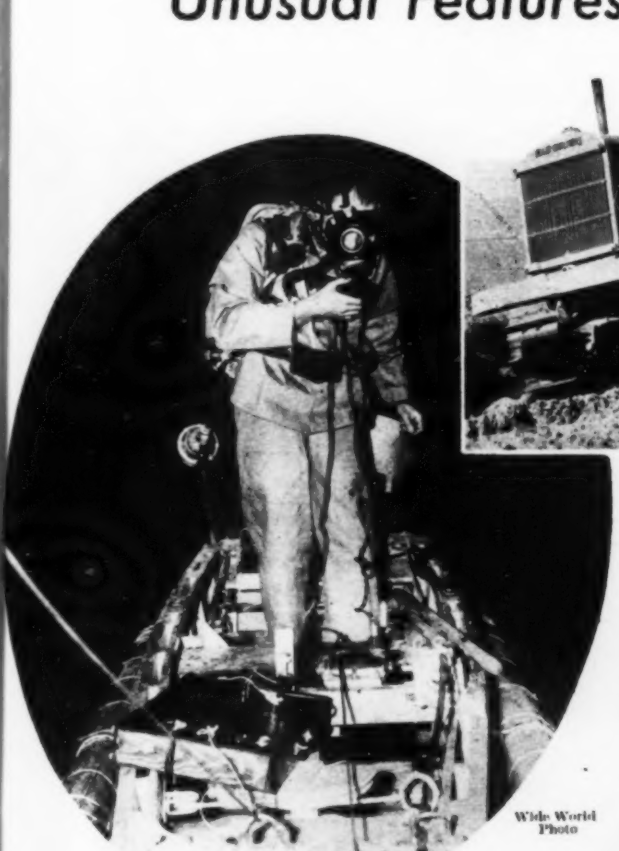
California Toll Bridge Authority Photo

RIDE, MISTER? Without known previous hitch-hiking experience, Col. Willard T. Chevalier *(left)*, president of American Road Builders' Association, vice-president of McGraw-Hill Publishing Co. and publishing director of *Construction Methods*, displays form of practiced artist in winning transportation from Chief Engineer C. H. Purcell after inspection of East Bay crossing of San Francisco-Oakland Bay bridge project.

U. S. Bureau of Reclamation Photo

A COOL SMOKE. Drill runner trimming bedrock at Grand Coulee dam takes long draft from water bottle without losing lip-hold on cigarette.

EASY AS PUSHING A DOLL CARRIAGE. Operation of Allis-Chalmers oil tractor *(left)* presents no difficulties to 12-year-old Elizabeth Wilcox, daughter of Chaves County, N. M., commissioner. Almost daily this young lady operates tractor or tractor-powered patrol unit.



Wide World Photo

FORTIFIED AGAINST GAS ATTACK by oxygen mask and special clothes which protect him from erosive atmosphere in Los Angeles sewers, Reuben F. Brown, assistant sewer maintenance engineer, begins inspection of 6 mi. of city's system, reporting periodically to engineers on surface by earth induction communicating set. Boat equipped with pontoons drifts downstream as steel anchor line is paid out from small windlass. Inspection involves daily trips for 1 month. Floodlights aid photographing of any acid erosions or earthquake cracks discovered.

FOUR-LEVEL TRAFFIC SEPARATION *(below)* in Stockholm, Sweden, provides water route on lowest level, underground railway (crossing boat basin on bridge at left), and two-level vehicular roadways connected by curved ramps.

Wide World Photo

California Traffic Striper

PUSHMOBILE TRAFFIC STRIPER *(left)* **for California highway consists of paint spray unit, equipped with long guide pointer, pushed by truck tender carrying paint tank and compressor connected by hose lines** *(in oval, above)* **to spray applicator.**

SPECIAL traffic-striping machines developed by the equipment department of the California Division of Highways now maintain 7,500 mi. of white stripe on 5,000 mi. of bituminous and concrete surfaces in the state highway system. Each of the eleven highway districts in the state is equipped with a striping outfit. Those in the Los Angeles and San Francisco districts operate almost continuously.

Each of the new outfits comprises a tender truck pushing a light, pneumatic-tired spray unit equipped with a rolling guide disk at the forward end of a long steering arm. A large-capacity paint tank and compressor are carried on the truck and are connected by hose to the spray unit. Provision is made in the design of the spray unit to permit cleaning of the pavement surface with compressed air prior to application of the striping lacquer. Some of the outfits have small pumps to salvage excess lacquer blown against the side plates which govern the 4-in. width of the line.

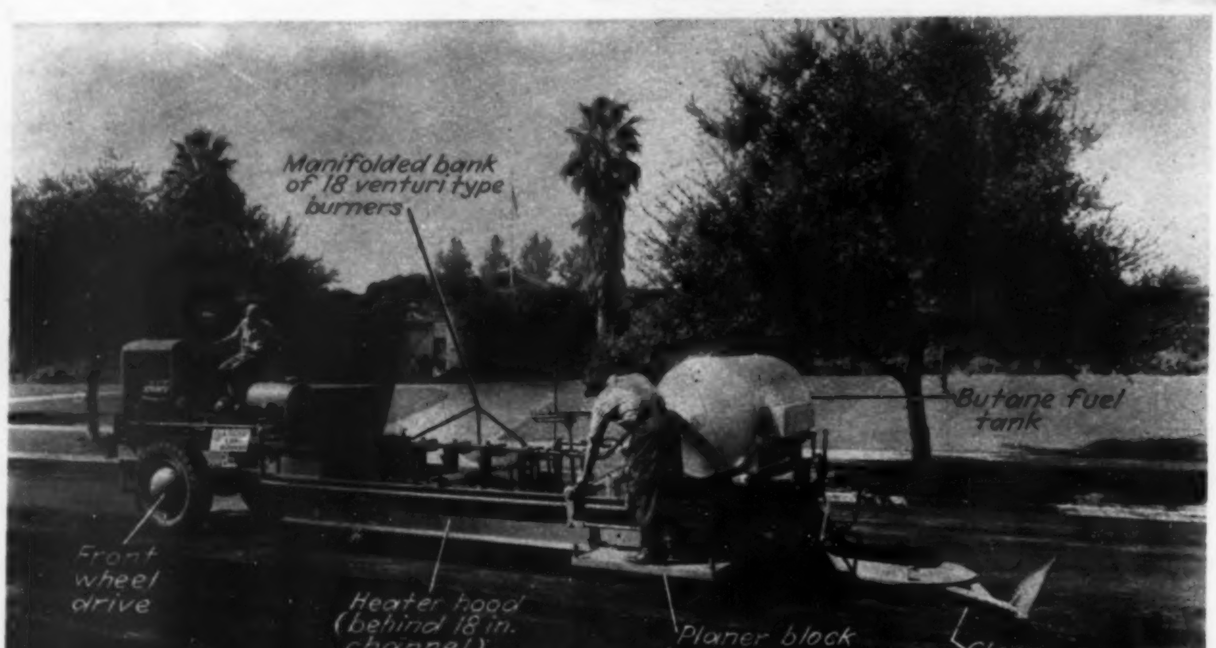
Small markers consisting of coiled wires carrying red flags are dropped from the rear of the tender truck to protect the fresh line and are picked up by a light following car when the lacquer has dried sufficiently. Specifications require that the lacquer dry in 15 to 30 min. The lacquer must give satisfactory coverage, resist discoloration when placed on an asphaltic surface, flow readily through the spray machine, adhere strongly to pavement surfaces and endure extremes of temperature as well as the abrasion of traffic.

A large mileage of striping work has been placed under contract at various times, and several California contractors have developed spray machines which are equal to the state units. Because of its intermittent character and the necessity of handling it promptly, striping usually is done by state forces.

On restriping work lacquer is applied at the rate of 8 to 12 gal. per mile of 4-in. stripe and on new work at the rate of 12 to 18 gal. per mile. An experienced crew places from 10 to 25 mi. of stripe per day and averages about 18 mi. per day. The cost ranges from $25 to $30 per mile, depending upon road and traffic conditions.

Heater Planer Restores Bituminous Surfaces

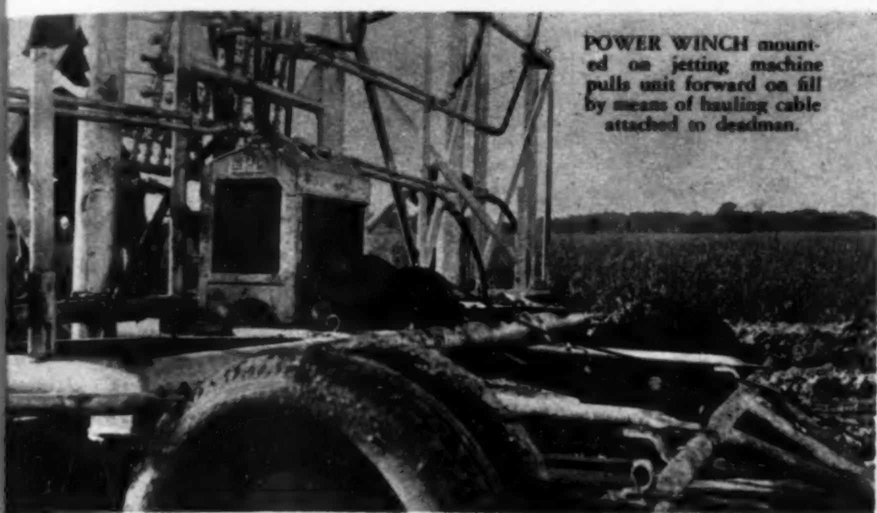
A SELF-PROPELLED heater-planer operated by A. Teichert & Son, Inc., contractor, of Sacramento, Calif., last fall reconditioned 583,000 sq. ft. of bituminous pavement in that city at a cost of 0.9c. per square foot. Working on various types of pavement, including cut-back plant-mix, bituminous concrete, and 25-year-old Warrenite, the machine leveled corrugations, removed slippery seal coats and excess fats and, in general, restored the pavement to true grade and uniform section with a non-skid surface texture. The Spearwell heater-planer used for this work combined the heating, cutting and strike-off operations in one continuous forward motion. From one to three trips of the machine sufficed to put the pavement in shape to carry traffic safely without need of retreading or patching, according to a report by Charles R. Blood, assistant city engineer. Two men operated the machine, which has sixteen speed changes for each speed of motor, controlled by throttle. The heater-planer averaged 21,000 sq. ft. of finished work per day.



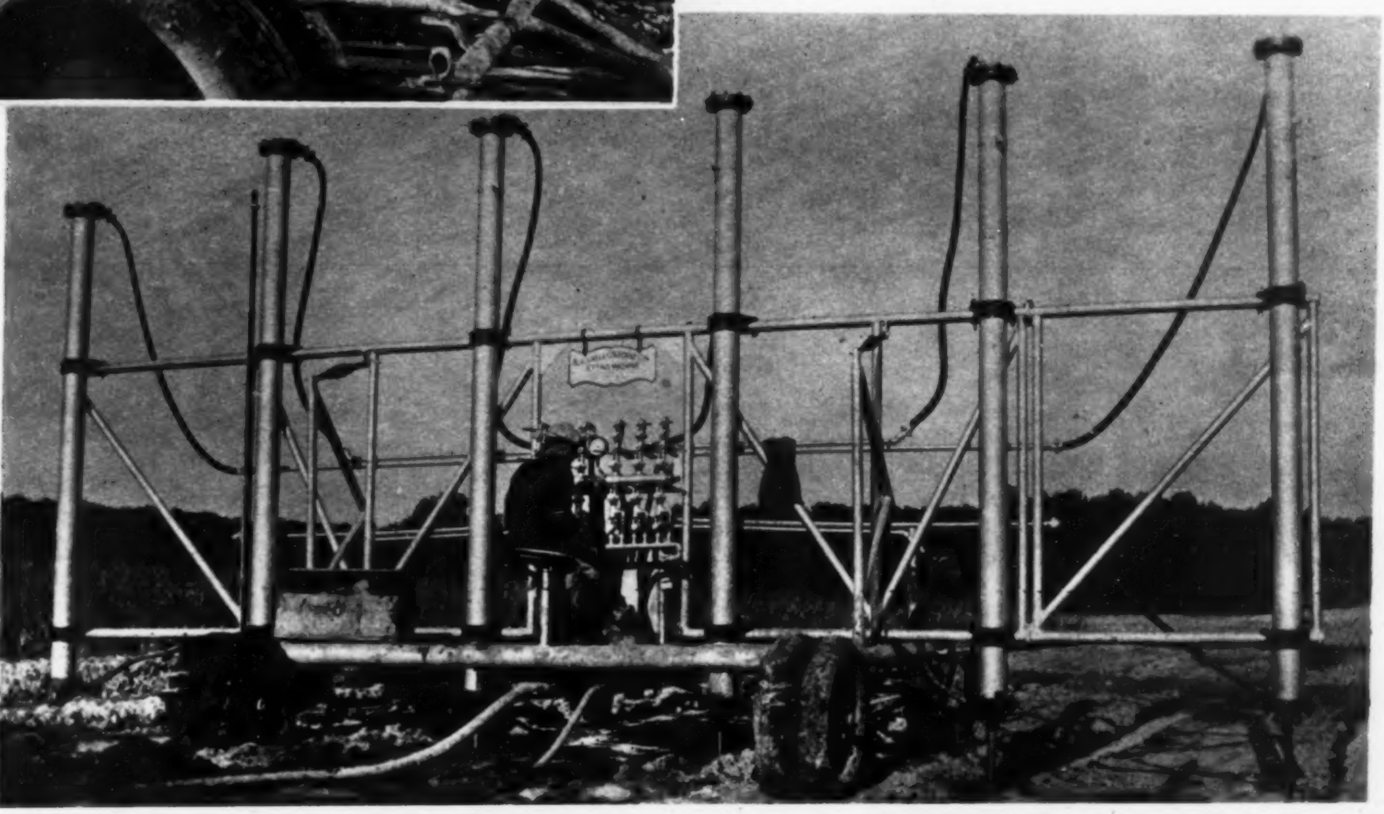
SELF-PROPELLED HEATER-PLANER in one continuous forward motion heats surface of bituminous pavement, planes corrugations and seal coat and strikes off material to true profile. While maintaining constant heat, machine adjusts forward speed to meet varying surface conditions. Hydraulic lifts control heater hood, planer block and clean-up blade.

Six-Point Jetting Machine

Consolidates Fresh Fills



POWER WINCH mounted on jetting machine pulls unit forward on fill by means of hauling cable attached to deadman.

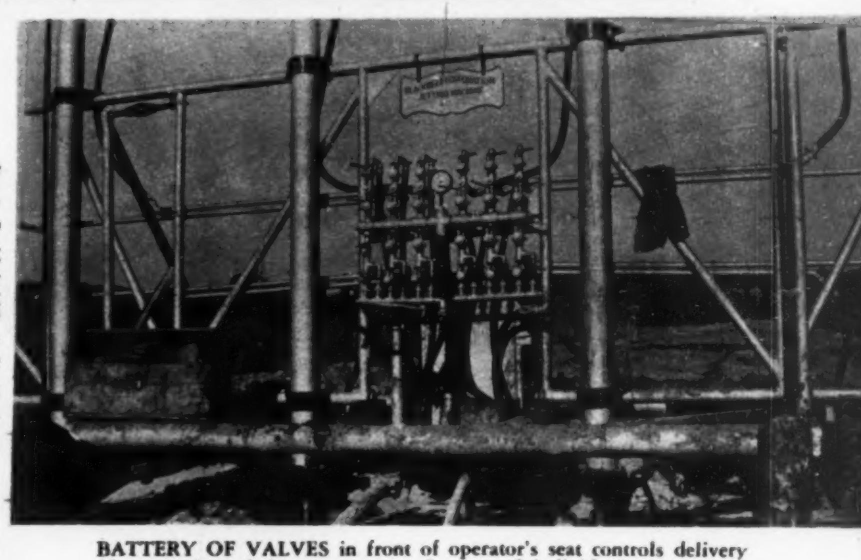


TRAVELING JETTING MACHINE carries six vertical tubes containing $\frac{3}{4}$-in. jet pipes which are mounted on pistons inside tubes. Water from road pump sinks points in highway fill and raises or lowers jet pipes.

A MOBILE jetting machine for saturating fresh fills to produce rapid settlement and complete consolidation has operated successfully on more than 2,000,000 cu. yd. of embankment in Illinois, penetrating to depths up to 32 ft. and compacting the fills for prompt paving. Developed by S. R. Blackwell and utilized by the Blackwell Corp., of East St. Louis, which performs jetting work under contract, the machine carries six vertical brass tubes of 6-in. diameter mounted in a transverse row on a tubular frame resting in turn on a welded pipe chassis supported by four pairs of pneumatic-tired wheels. Inside the tubes are $\frac{3}{4}$-in. I.D. jet pipes 12 ft. long attached at their upper ends to pump-type pistons sealed with packing against the cylinder walls. Water for jetting and for raising and lowering the pistons is supplied through $2\frac{1}{2}$-in. pipe line from a road pump at the source. An operator raises and lowers the jets independently through individual valves or operates them in unison by means of a master valve.

Jetting can be carried to a depth of 11 ft. by the piston-mounted pipes in the vertical cylinders. To go to greater depths, the pipes are raised and swung clear of the jet holes to permit 11-ft. extensions of $\frac{3}{4}$-in. pipe to be set in the holes. The cylinders then are swung back into position, and the extensions are attached to the piston-operated pipes by threaded connections. A battery of valves to control the six jets is placed at the center of the chassis in front of the operator's seat. As indicated by the photographs, hose connections to the tops of the 6-in.-diam. vertical cylinders furnish water under pressure for jetting, while similar connections to the bottoms of the cylinders supply water for raising the pistons. In operation, the machine sinks plumb holes with unsealed walls under complete control of one man. After the unit has been set in motion, jetting ordinarily is carried on with the six points in unison by means of the main valve.

Spacing of the jets can be adjusted by moving the cylinders on the tubular frame from $4\frac{1}{2}$ ft. to 6 ft., c. to c. The outside jets are mounted on hinged tubular wings of the main frame. To transport the machine between jobs, these wings are folded back, and the wheel trucks (designed for this purpose) are revolved through 90 deg. under the tubular chassis, reducing the width of the unit. In this condition, a drawbar at the front of the trucks is attached to a motor truck,, and the machine is pulled to the next site. When set up for jetting on a fill, the machine pulls itself forward by means of a power winch on the chassis. A hauling line from the winch is anchored to a deadman ahead of the unit.



BATTERY OF VALVES in front of operator's seat controls delivery of water through hoses to top or bottom of individual vertical cylinders. Master valves permit operation of six jets in unison.

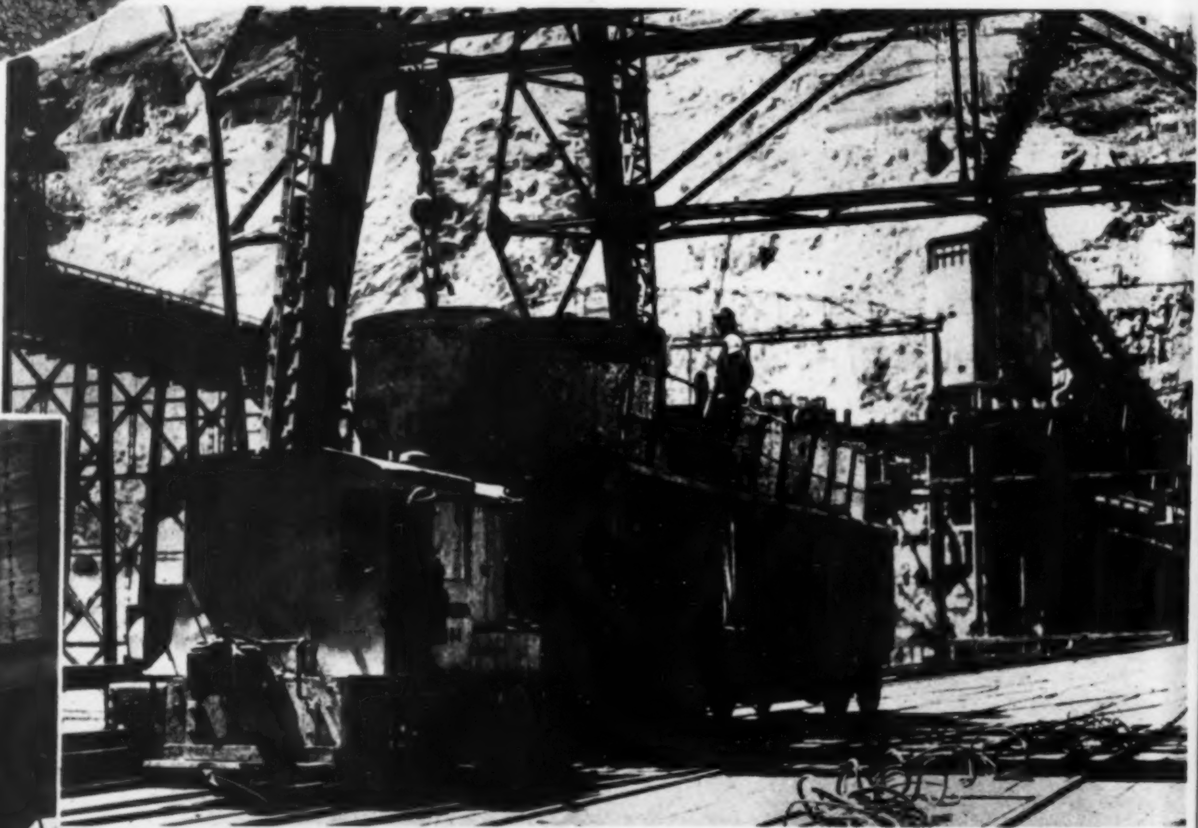
Getting Down to

DETAILS

Close-Up Shots of Job Methods and Equipment

U. S. Bureau of Reclamation Photo

4-YD. ROLLER-GATE BUCKET dumps load of concrete in Grand Coulee dam. Signalman standing on forms telephones directions for handling buckets to crane operators on trestle above. Electric vibrators consolidate mass concrete. SPECIAL FLAT CAR *(right)* moved by diesel-electric locomotive carries five 4-yd. buckets between west mixing plant, in background, and hammerhead or whirley crane on downstream (low-level) trestle. Similar cranes and cars operate on upstream (high level) trestle, at left. With both east and west mixing plants in operation Mason-Walsh-Atkinson-Kier Co. will use sixteen diesel-electric driven flat cars carrying five buckets each.



SECOND WASHING of gravel en route from overhead bins to railroad cars at crushing, screening and washing plant of Walsh Construction Co. assures clean coarse aggregate for concrete going into bridges and retaining walls of New York Central track elevation contract in Syracuse, N. Y. TWO SPRAY BARS *(right)* above inclined screen-bottom chute remove any silt which may have settled in gravel bin. Water falls through screen to drip pan which discharges it beyond edge of railroad car.

ANGLEDOZER ATTACHMENT *(below)* supported on track frame of tractor moves earth, boulders and broken rock on Idaho grading contract of Quinn Robbins Co. along Payette River, between Horse Shoe Bend and Emmett, where Le Tourneau unit is bulldozing 80,000 cu. yd. of material taken from highway cuts containing about 10,000 cu. yd. of solid rock.

WANTED —

Photos of Details

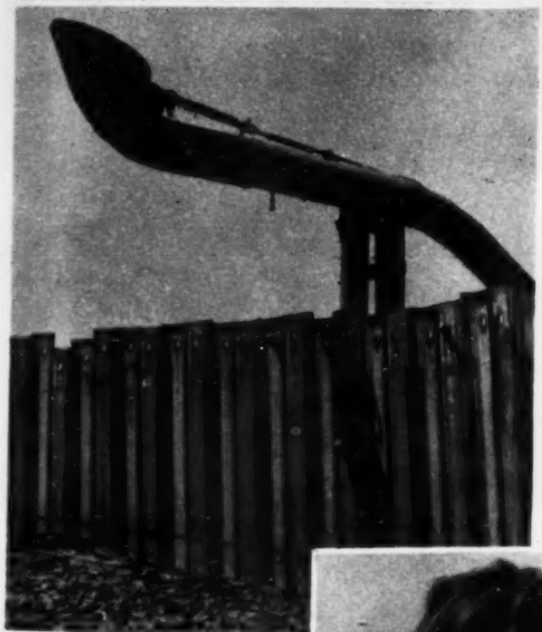
The Editor of Construction Methods wants photographs or sketches illustrating interesting DETAILS of method or equipment and will pay for those he finds acceptable for publication.

Hasn't your job produced some DETAIL that might be illustrated on this page? Send along a picture of it; we'll return it promptly if we can't use it.

TILE TRAFFIC-LINE MARKERS *(left)* separating six lanes on upper deck of San Francisco-Oakland Bay bridge are dropped through openings in mobile templet into fresh pavement concrete and embedded flush with surface. Double row of tile markers separates eastbound and westbound traffic.

California Toll Bridge Authority Photo

THIN DISK *(above)* mounted in lower end of pipe handle opens slot in V-shaped metal strip (with flange anchored in 10-ft. concrete lane previously placed) to permit insertion of one leg of metal cap *(left)* covering premolded filler in longitudinal joint on New Jersey concrete paving contract of P. Camillo & Co., Inc., Westfield, N. J. Flange on outer (near) side of cap, which is shaped like inverted U, will be embedded in concrete of second lane, forming watertight seal across premolded joint material. Top of joint will be filled above cap with hot bituminous filler material.



DISCHARGE SPREADER shaped like inverted suction hood of sand-sucker dredge distributes hydraulic fill in cofferdam cells at Peoria lock on Illinois River, Peoria, Ill., where Great Lakes Dredge & Dock Co. is pumping fill under direction of U. S. Engineers. SPRAY *(right)* indicates effectiveness of spreading device.

U. S. Bureau of Public Roads Photo

STEEL PEDESTAL (one of four under end posts of existing through-truss bridge) raises structure to grade on public works highway project in Davis County, Iowa. Pedestals are to be incased in concrete.

Control MAKES THE DIFFERENCE

SPONTANEOUS COMBUSTION VS. CONTROLLED IGNITION

A pile of greasy wipe rags in the corner. Heat generates . . . and sooner or later . . . pfoof! . . . building and equipment go up in flames. Spontaneous combustion is *uncontrolled* . . . and is the direct opposite of Controlled Ignition.

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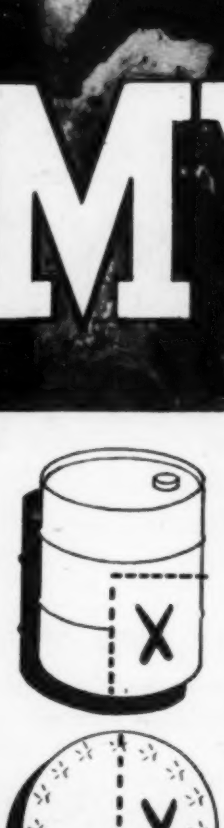

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NINTH OF A SERIES OF ARTICLES

Planning and Plant for HEAVY CONSTRUCTION

Principles and Practices of Job Layout and Selection and Use of Equipment for Large Dams and Appurtenant Works

By ADOLPH J. ACKERMAN and CHARLES H. LOCHER

Construction Plant Engineer — *Construction Consultant*

TENNESSEE-VALLEY AUTHORITY, KNOXVILLE, TENN.

. . . 9 . . .

Diversion of Rivers

Diversion Tubes and Channels

DIVERSION of the river out of its natural bed is generally the most important and most critical operation in the construction of a dam. In the case of wide rivers cofferdamming has normally proceeded from one or both sides, and the structures built within these cofferdams contain notches or diversion tubes designed to carry the river during the period when construction is under way in the remaining portion of the natural bed.

In the case of narrow canyon projects the customary procedure is first to build tunnels parallel to the river around the site of the dam. A barrier is then thrown across the river above the dam site and the water is diverted through these tunnels. A similar barrier near the downstream end of the tunnel closes off the dam site so it may be unwatered and construction can proceed thereafter without interruption. The best known project employing this method is Boulder dam shown in Fig. 1. A similar procedure has been used on a number of large Western projects such as Owyhee, Baker River, Parker, Skagit and others. In the case of Boulder dam the importance of the diversion barrier, or dam, near the upstream end of the tunnel was sufficiently great to justify special preparation of its foundation.

The design of adequate capacities for the diversion channels together with their necessary diversion cofferdams obviously involves major problems of construction economics. Where the construction is carefully timed so that uncovering of the foundation occurs during the low water season when river handling problems are reduced to a minimum, important economies are possible, as, for example, in the case of Horse Mesa dam shown in Fig. 2, where a timber flume carried the low-water discharge until it was possible to raise the concrete structure to a point where larger passageways through the dam could handle the larger floods. Such flumes are particularly economical where the discharge is less than 1,000 sec.-ft.

Fig. 3 . . . STREAMLINING of inlet of temporary diversion tunnel at Calderwood dam increases capacity of tunnel 15 to 20 per cent over square-faced inlet.

Fig. 2 . . . TIMBER DIVERSION FLUME bypassing river at Horse Mesa dam, in Arizona.

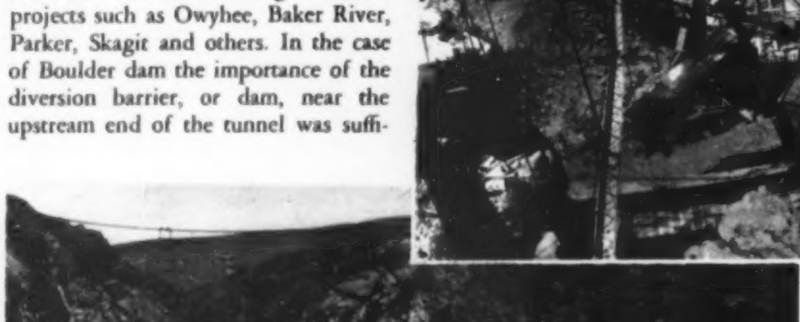


Fig. 1 . . . OUTLETS of 50-ft. diameter diversion tunnels at Boulder dam. Diversion service has been discontinued on two of them at this stage of construction.

In many cases, of course, the river is too large to be handled by a flume, and it is then customary to leave the river in its bed until the adjacent structures have been built up and provided with adequate openings to carry the diverted river. These openings or diversion tubes sometimes require very careful design and study of their discharge capacities on a hydraulic model. This applies particularly to projects where space is limited and every effort must be made to develop a high efficiency of discharge. Under low efficiency it follows that the head must be correspondingly greater to pass a given quantity of water, and when this head is considered in connection with building the diversion cofferdam it is at once obvious that the increased height of this cofferdam, together with the greater difficulty of closing the channel, means a substantial increase in cost of diversion.

Fig. 3 shows the inlet of a properly designed diversion tube. The specially formed concrete bellmouth inlet increased the capacity of this diversion tube approximately 15 per cent over the ordinary square-edged inlet and resulted in a substantial reduction in head on the adjacent cofferdam. This process of increasing the discharge capacity is generally cheaper than enlarging the diversion tubes because of the greater cost of closure gates and filling operations for the larger openings.

Sometimes it is necessary to provide special diversion channels for large discharges, as for example, 75,000 sec.-ft. at Madden dam, which was briefly

described in a preceding chapter. The river passed through this channel during the low-water season just before steps were taken to close it. Short extensions of the draft tube piers of the power-house substructure projected above the water level. These piers contained stop log grooves which were used to close off the downstream end of the channel, thereby saving the cost of a temporary cofferdam. At the upstream end a series of rock-filled cribs were lowered into place, after which construction was able to proceed in the entire channel area.

Fig. 5 . . . THREE SECTIONS OF COFFERDAM at Wheeler dam protect concrete structures nearing completion. Fourth cofferdam section (in background) is unwatered while river flows through section ultimately to be inclosed by fifth cofferdam.

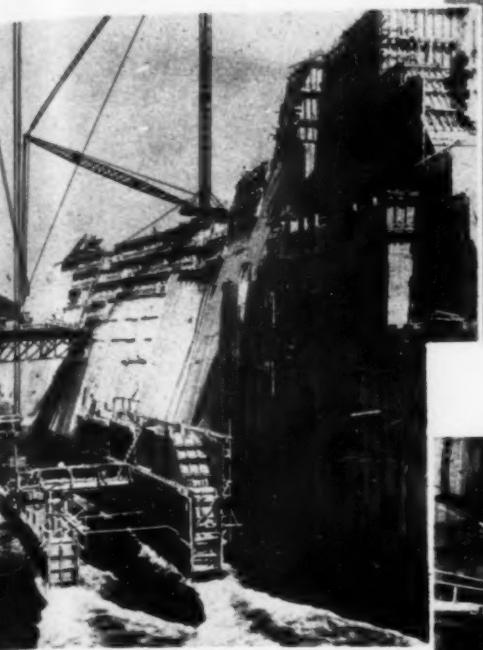


Fig. 4 . . . DIVERSION CHANNEL is left in one end of dam at Bingham, Me. Two piers ultimately serve as intermediate supports for system of closure panels which slide into place on upstream side.

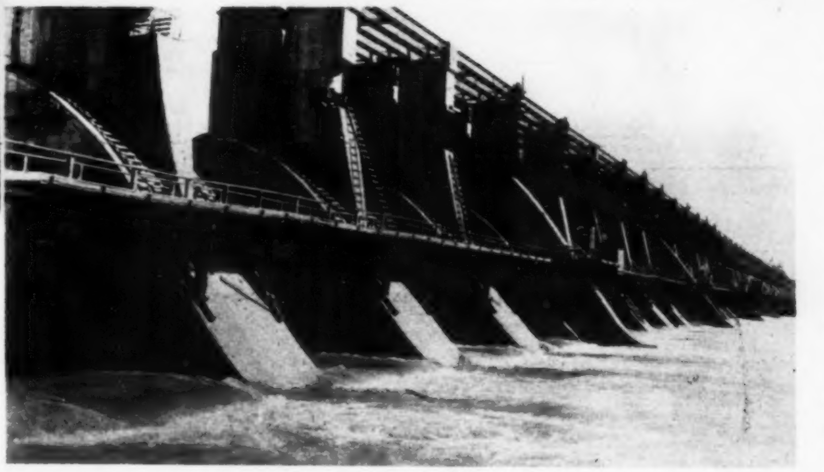


Fig. 6 . . . NOTCHES in Wheeler dam carry flow of Tennessee River during construction.

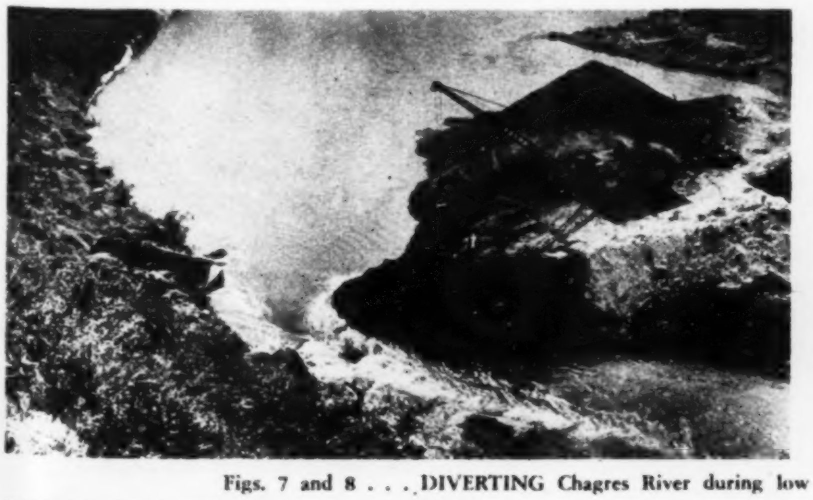
A further example of a diversion channel left in one section of the dam at Bingham, Maine, is shown in Fig. 4. This channel has intermediate piers to reduce the span of the closure gates which were later lowered across the inlet to cut off the discharge and direct the water into other controllable passageways while the placing of concrete was under way in this channel.

In the case of extremely wide rivers as, for example, the Tennessee, with discharges ranging up to 250,000 sec.-ft., it is necessary to provide extensive passageways for the large floods. Fig. 5 shows the Wheeler dam during the low water season with the structures in three sections of cofferdam nearing completion and the fourth one unwatered, while the river is passing through the section ultimately inclosed by the fifth cofferdam. Before the end of the low-water season the fifth cofferdam was thrown across the open channel and the water directed through notches left in the partly completed section of the dam, as shown in Fig. 6. The floor of these notches was above tail water and above the floor of the intake structure in the powerhouse section. This intake structure was designed for the future addition of generating units but during the latter stages of construction carried the river. At low water it was all carried by the intakes and the notches were exposed so that concreting proceeded without interference from the water, except for one small group of notches which were closed off by a special type of structural steel form lowered against the upstream face of the dam.

The use of the permanent passageways through the dam to carry the water during construction can often lead to substantial economies.

Methods of Diverting Rivers — Probably the most spectacular phase in the construction of the dam occurs when the river is diverted out of its old bed and is forced to accept temporarily a man-made course before it is finally converted forever into a tranquil lake upon completion of the dam.

One of the simplest methods of diverting a river is by means of an earthdam plug, as employed by R. M. Conner in diverting the Chagres River at Madden dam. This closure is shown in Figs. 7 and 8. A part of the river was already passing through the diversion channel whose bottom was sufficiently low to prevent the necessity of raising the water very much in making diversion. Combined with this feature was an unusually low stage of river discharge, but in spite of this it required many hours of feeding boulders and dirt into the gap before the river finally yielded and permitted itself to be choked off. Once the river was diverted, it was a simple matter to construct a crib cofferdam at the downstream end. These cribs were set directly on the gravel bottom and a steel sheetpile seepage cut-off was



Figs. 7 and 8 . . . DIVERTING Chagres River during low water season by means of earth dam plug placed by dragline.

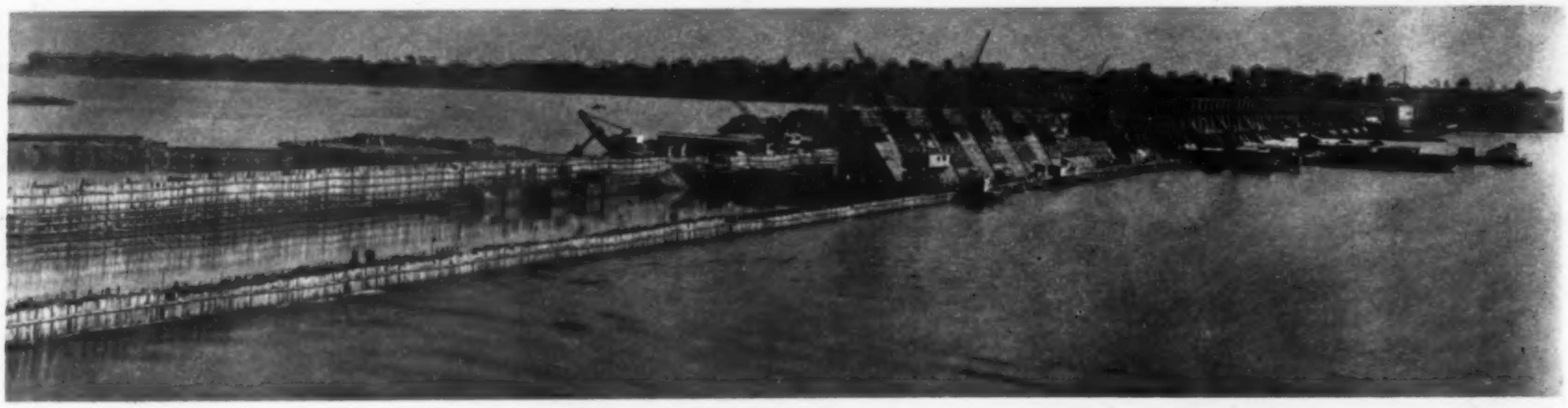


Fig. 9 . . . COMPLETED COFFERDAM at Wheeler dam across final section of river bed. Note rock fill, at extreme left, which was first dumped across channel to cut off velocity of water. River is passing through low notches in partially completed section of dam.

driven along the face of the cribs extending down to rock. With this diversion completed, the river section was unwatered and construction of the main dam proceeded without delay.

The real fight on a river, of course, occurs when the construction has developed a substantial head through the remaining open section, and in many cases the water is too swift for any earth or small stones to remain in place. In such cases, it is necessary to use large rocks and boulders and build a rock-fill barrier which has sufficient stability to choke off the water, as was employed by G. P. Jessup at Wheeler Dam, as indicated in Fig. 9. After this barrier had been substantially sealed off with smaller

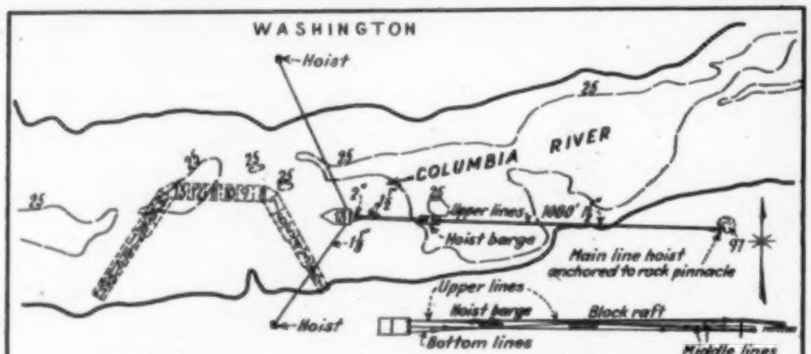


Fig. 10 . . . GENERAL PLAN of holding lines on cofferdam cribs at Bonneville dam on Columbia River.

shows one of a large number of Kaoliang plugs being fitted into place against a discharge of 452 sec.-ft. This plug was built upon a woven willow mattress and consisted of a mixture of stalks, stone and earth strongly tied together with hemp rope. Downstream displacement of the plug during lowering was prevented by a system of ropes extending to points of anchorage on the upstream side, as well as by means of a band of ropes running along the upstream face of the dike and around the back end of the plug.

Fig. 12 shows an unusually interesting method of diversion under higher velocity by means of dumping willow and stone "sausages" into the

Fig. 11 . . . KAOLIANG PLUG being fitted into place against flow of 15 cu. meters per second on Yellow River, China.

Fig. 12 . . . DUMPING A "SAUSAGE" of willow and stone into the final closure with water at high velocity in Yellow River, China.

gravel and earth, an Ohio River type of water-tight cofferdam was constructed behind it to provide an effective seal across the last section of the river bed. In general, it is feasible to divert by means of earth or a combination of earth and rock against heads of 1 or 2 ft. and by means of heavy rock fills against heads of 2 to 4 ft.

It is of considerable interest to note some of the primitive methods employed in the diversion of a river described in *Engineering News-Record,* May 21, 1936, (pp. 735-738), in connection with the diversion of the Yellow River in China. Fig. 11

Fig. 13 . . . CLOSURE CRIB being floated into place for Rock Island dam cofferdam on Columbia River in Washington.

channel. Approximately 1,000 of these sausages were used on the Yellow River, varying in length from 16 to 50 ft.; they were rolled into water varying in depth from 22 to 33 ft. and under a maximum head of 6 ft. The sausages consisted of a system of willow branches surrounding a core of large boulders and stones, all tied together with hemp rope. They were rolled into place by hand as shown in the picture, with their upstream ends tied to anchorages, and where the ropes failed, the entire sausage would be carried downstream several hundred feet. According to O. J.

Fig. 14 . . . BEGINNING EXCAVATION for power house at site of Hodenpyl dam on Manistee River in Michigan.

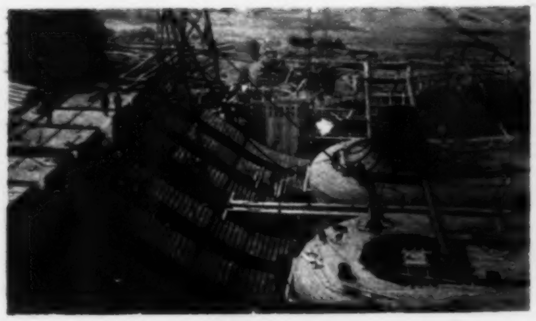


Fig. 15 . . . FORMS for spillway tube under powerhouse structure and draft tube forms, forming passageway for river during construction. Spillway gates later closed to impound water.

Fig. 16 . . . DRIVING PILES in river section for diversion barrier. Construction progress on power house shown in background.

Fig. 17 . . . DIVERSION BARRIER completed and power house ready to receive river. Note large pile of poles at right end of barrier.

Fig. 18 . . . DUMPING POLES *(below)* and bundles of brush between timber piling to choke off river on big day when "turning the river" was accomplished.

Fig. 19 . . . SLUICING down sand from left bank of river to fill voids between poles and brush. Bundles of pine twigs are being sent down from top of bank.

Fig. 20 . . . SLUICING SYSTEM and trough on diversion barrier, with river completely choked off.

"Turning" a River in Michigan

Fig. 21 . . . EARTH DAM SECTION across main river channel is almost completed.

Potts who served as consulting engineer on this work, 25,000 men were employed at the peak of diversion operation, the low wage scale accounting for the absence of mechanical equipment and more modern methods.

When it comes to choking off the discharge, particularly in the last section under heads of 4 to 5 ft., or greater, the rock-filled crib is usually the most common expedient where the river bottom is solid rock or of a material sufficiently stable to support heavy cribs without undermining them. In the case of such rock-filled cribs the last one or two cribs must usually be placed with very reliable control by means of cables anchored to the shore and to other points upstream from the working area. Among the most difficult crib handling jobs are the ones employed on the Columbia River at Rock Island dam, a Stone & Webster Engineering Corp. project, and more recently on Bonneville dam. Fig. 10 shows a general plan of holding lines employed on the cribs at Bonneville. Figs. 13 and 22 show river conditions which these rock-filled cribs had to withstand at the Rock Island dam.

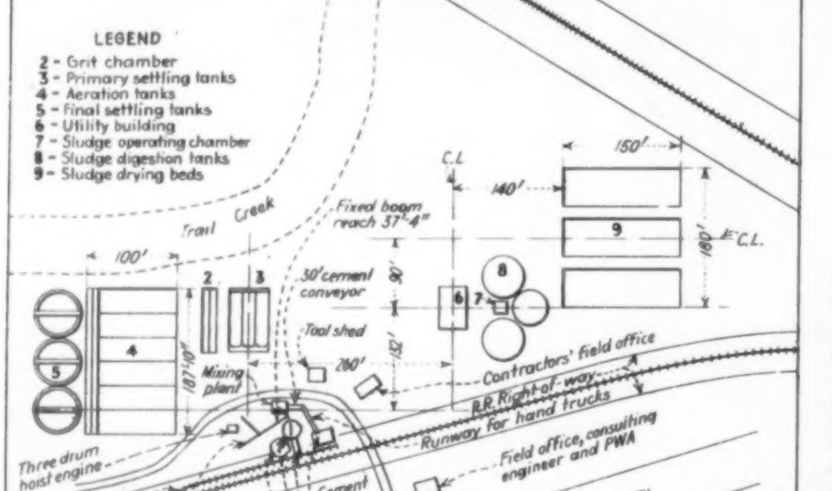
Turning A River In Michigan—Figs. 14 to 21 show an interesting series of views of the Hodenpyl project on the Manistee River in Michigan, built by the late E. M. Burd. "Turning the river" was a keenly anticipated event in which every man on the job lent a hand. Preparatory work included the driving of a system of timber piling acriss the river together with a steel and Wakefield pile cutoff in the river bed extending only a few inches above the bottom to form an effective stop against undermining of the diversion structure. A plentiful supply of poles had been placed near this barrier and bundles of evergreen brush about the size of a bushel basket were made up in large quantities. A system of metal chutes and one or two hydraulic giants for washing down sand into the barrier structure were placed in readiness.

On the eventful day the barrier structure was alive with men carrying poles and bundles of brush and depositing them in alternate layers between the rows of piling. The sand was washed down into this mass and slowly but surely the river was choked off and effectively sealed, thereby forcing it into a new channel. This channel led the water into special submerged spillway tubes connecting with the upstream end of the draft tubes to form a continuous passageway through which the river was permitted to pass until the reservoir was ready for impounding, at which time the gates at the upstream end of the tubes were lowered into place.

Fig. 22 . . . UPSTREAM COFFERDAM for Rock Island dam on Columbia River in Washington.

NEXT MONTH — Chapter 10 of the series on "Heavy Construction", by A. J. Ackerman and Charles H. Locher, to appear in the September issue will deal with "Making Final Closures."

CENTRAL MIXING PLANT supplied with materials from cars on siding at left produces 5,500 cu. yd. of concrete for sewage treatment works. Sack cement is trucked over runway from storage shed in foreground to belt conveyor which elevates sacks to charging platform. Mixer discharges into concrete buckets on motor truck.



LAYOUT OF SEWAGE TREATMENT WORKS and construction plant indicates location of aggregate piles, cement shed and mixer. Fixed boom of stiff-leg derrick handles sand and gravel into overhead bins above mixer.

OPEN TRENCH

Unwaters Sand Subsoil for Sewage Plant Foundations

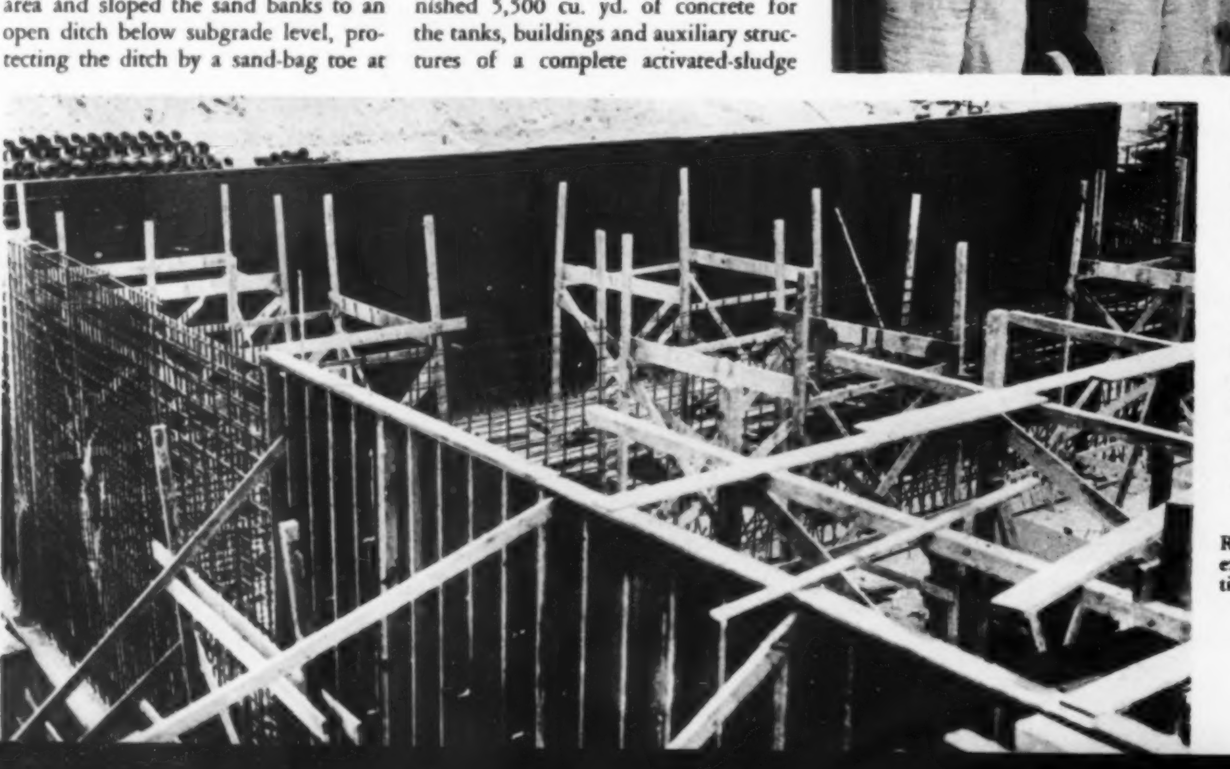
TO UNWATER a sand stratum underlying the site of the aeration tanks and final settling tanks of the Michigan City, Ind., sewage treatment works, Cope & Fisher, of Decatur, Ill., contractors for the entire plant, excavated the foundation area and sloped the sand banks to an open ditch below subgrade level, protecting the ditch by a sand-bag toe at the foot of the slope and by shiplap sheeting on the inside, adjacent to the footings. By this method the contractors avoided expensive cofferdamming and the use of wellpoints.

A central mixing plant set up along a railroad sidetrack at the site furnished 5,500 cu. yd. of concrete for the tanks, buildings and auxiliary structures of a complete activated-sludge treatment plant. Structural concrete was cast against plywood forms made up in panels for repeated use. An air-driven vibrator consolidated this concrete.

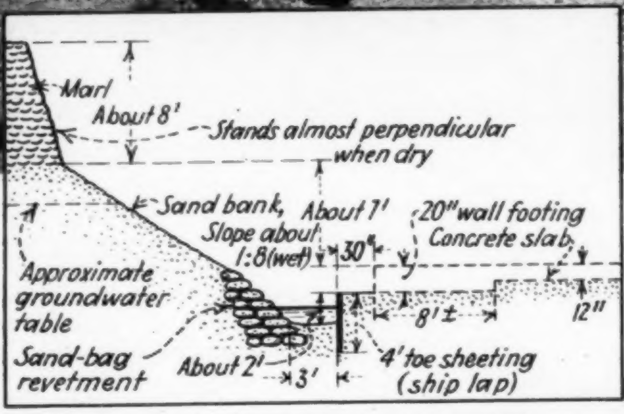
Treatment Works—Situated in low-lying bottom lands along Trail Creek, the various units of the sewage treatment works are distributed over an area of 4 acres. The plant was designed by Charles H. Hurd, of Indianapolis, Ind., consulting engineer, for complete activated-sludge treatment of the sewage. Sludge is disposed of in separate digestion tanks, and the gas there generated is used for power and for heating the plant.

In addition to a battery of three aeration tanks, 188x100 ft. in area by 16 ft. deep, and three 55-ft.-diameter final settling tanks, undertaken during the initial stage of construction, the Cope & Fisher contract, valued at $322,000, included a grit chamber, primary settling tanks, sludge digestion tanks, sludge drying beds, a sludge operating chamber and a utility building. For these units the contractors removed 12,000 cu. yd. of dry

DIRECTING CONSTRUCTION of sewage plant at Michigan City, Ind.: *(Left to right)* Richard P. Frame, city engineer; L. N. Fisher, of Cope & Fisher, contractors; J. A. Piersol, resident engineer for Charles H. Hurd; and W. R. Stonne, contractors' superintendent.



REINFORCING STEEL *(left)* for exterior and interior walls of aeration tanks is erected prior to placing of plywood form panels.



DRAINAGE TRENCH in wet sand under marl overburden conducts groundwater to sump and dries aeration tank site for construction of footings and floor slab.

GROUNDWATER CONDITIONS resulting from proximity of Trail Creek require subsoil drainage to permit construction of concrete wall footings and floor slabs for aeration tanks at left.

RESIDENT SUPERVISOR *(right)* for PWA, which supplied funds for project, is W. P. Cottingham, engineer-inspector.

excavation and 3,500 cu. yd. of wet excavation. Of the 5,500 cu. yd. of concrete involved in the contract, about 3,500 cu. yd. was structural, and this concrete was reinforced with 530 tons of steel bars. Because of unstable subsoil encountered under the northwest corner of the aeration tanks and under the north and middle final settling tanks, the contractors drove 500 timber piles 25 to 45 ft. long to carry the foundations and floor slabs in this area.

Drainage Trench — Groundwater level at the site of the areation tanks is about 4 ft. above subgrade of the wall footings, which are founded on sand about 13 ft. below the surface of the ground. Above the saturated sand stratum is a layer of marl about 8 ft. thick. This material when dry will stand on an almost vertical slope.

To lower the groundwater level inside the aeration tank area, the contractors dug an open trench $2\frac{1}{2}$ ft. outside the edge of the wall footings, sloping the wet sand bank on a gradient of about 1 in 8 and letting the marl stand almost vertical. The trench, extending completely around the aeration tanks, was excavated to about 4 ft. below subgrade of the foundations and to a width of perhaps 5 ft. At the toe of the sand bank, the contractors built a thick revetment of sand bags to prevent the bank from sliding into the ditch. A line of shiplap timber sheeting, toed into the bottom of the trench, retained the sand on the side adjacent to the concrete footing. After the trench had been in use for a short time, it filled with sand and silt to a depth about 2 ft. below footing grade, as indicated by the accompanying sketch. Water in the trench flowed to a sump from which it was removed by pumps. The trench sufficed to drain the entire area and to permit concreting of wall footings and floor slabs in the dry.

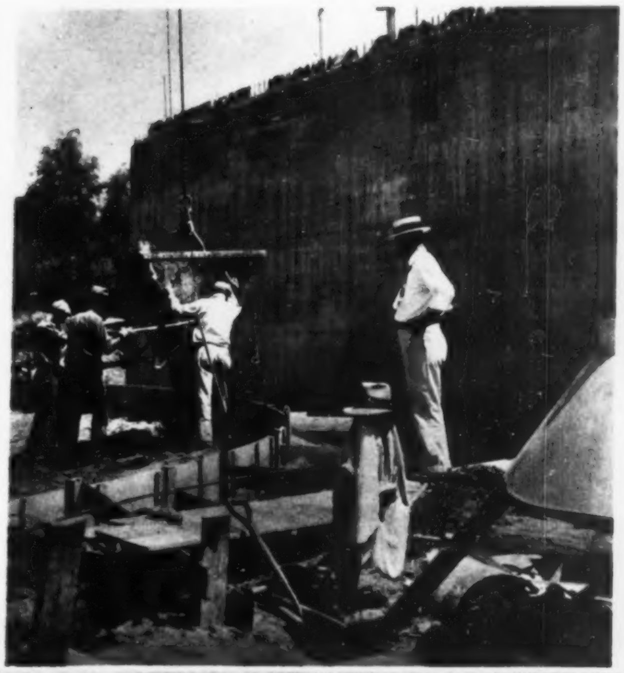
Concrete Plant — When concreting footings, floor slabs and walls, the contractors placed about 100 cu. yd. in a day of two 5-hr. shifts. The concrete was designed on a basis of 1.7 bbl. of cement per cubic yard, and the proportions of sand and gravel were adjusted to produce a workable mixture satisfying the placing requirements in the structure to which the concrete was being delivered. A central plant equipped with a 21-cu. ft. mixer produced the concrete.

Sand and gravel were stored in steel overhead bins built up with timber sides to hold 30 cu. yd. each. Sand was measured in a hydrographic batcher and gravel in a volumetric batcher. Cement was handled in sacks.

A specially built 24-in. by 30-ft. belt conveyor unloaded sand and gravel from a track hopper to reserve storage piles. A steam-powered stiff-leg derrick handling a clamshell bucket transferred sand and gravel to the overhead bins from either railroad cars or stock piles. The plant was so laid out that the derrick could fill the bins with materials from either source without changing the boom angle.

Sacked cement was unloaded from box cars into a storage shed beside the track. From the storage shed, it was wheeled by hand trucks over a short runway to the foot of a 30-ft. belt conveyor which delivered the sacks to the charging platform above the mixer. An accompanying drawing indicates the layout of the plant.

Concrete discharged from the mixer into 1-yd. bottom-dump buckets which were transported by truck to the site of placing operations. A crawler crane

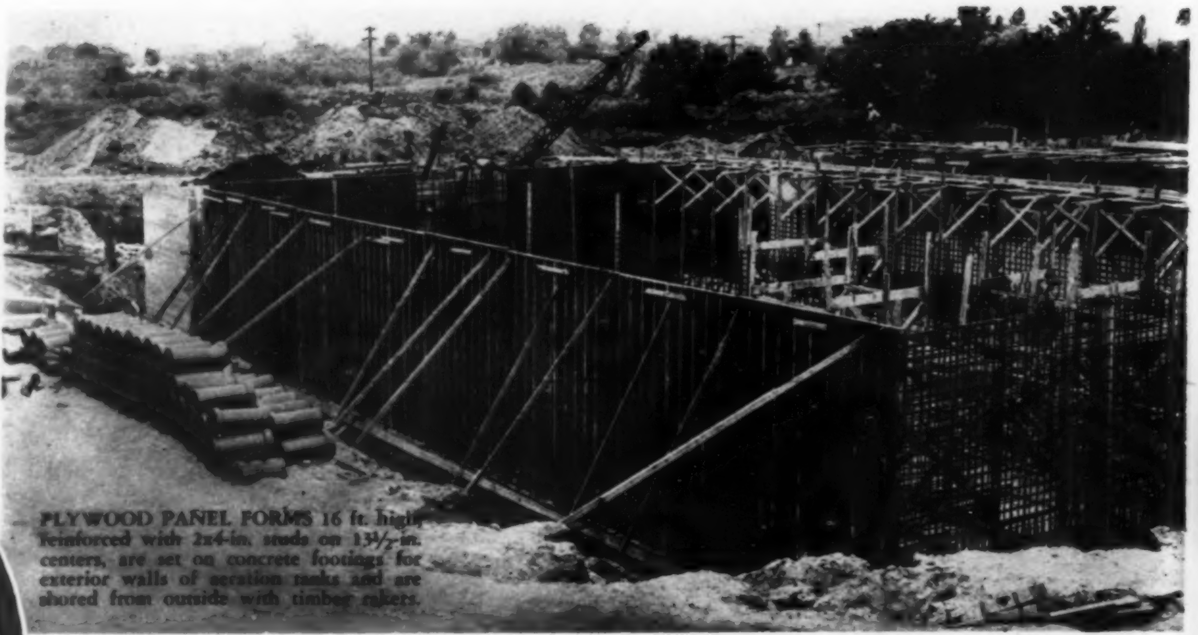


BOTTOM - DUMP BUCKET of 1-yd. capacity places concrete on timber foundation piles of final settling tank adjacent to creek.

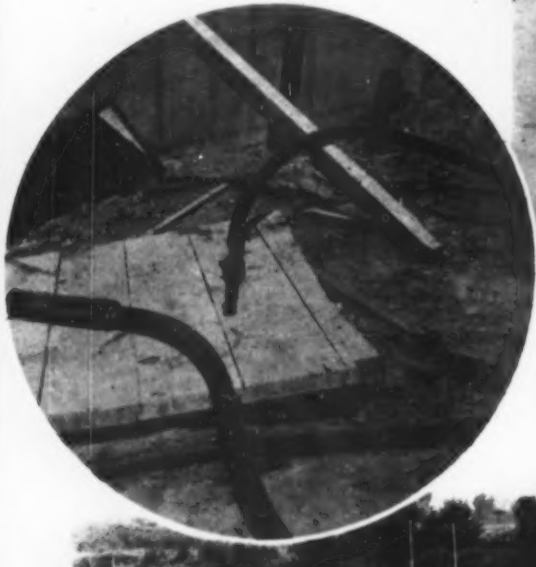
50-FT. BOOM of crawler crane handles concrete bucket from truck to footings of settling tank.

with a 50-ft. boom ordinarily handled the concrete buckets into position for dumping. For structures such as the interior walls of the aeration tanks, which could not be reached by the crane, concrete was discharged into a floor hopper and delievered to the forms by hand carts.

Vibration — After trying various types of vibrators, the contractors elected to use a Chicago Pneumatic air-driven vibrator because this tool seemed to them to accomplish more work than any of the other units tested.



PLYWOOD PANEL FORMS 16 ft. high reinforced with 2x4-in. studs on 13½-in. centers, are set on concrete footings for exterior walls of aeration tanks and are shored from outside with timber rakers.



AIR-POWERED VIBRATOR *(in circle)* has air motor inclosed in 3x15-in. vibrating tube for use in narrow walls. Exhaust air escapes at end of 20-ft. flexible hose handle, which is equipped with hand throttle.

Y-SHAPED INTERIOR WALLS *(left)* of aeration tanks are formed with 4x6-ft. plywood panels.

A 3x15-in. sausage-type vibrator was selected to operate between the reinforcing bars in narrow walls, some of which are only 10 in. thick. An air motor elastically supported in the vibrator tube revolved an eccentric weight mounted on ball bearings at 6,000 r.p.m. Air was supplied through an inner hose inside the main hose, 20 ft. long. The main hose conducted exhaust air from the motor and discharged it at the other end, 20 ft. from the vibrator. Air consumption amounted to 25 c.f.m. at 100-lb. pressure.

By the use of vibration and plywood forms, the contractors reduced finishing costs to a minimum. Exposed surfaces were rubbed where necessary with air-driven carborundum disks. A portable compressor supplying 110 cu. ft. of air per minute operated the vibrator and the grinders.

Concrete Forms — With the exception of the exterior walls of the aeration tanks, forms for which were made up to the full 16-ft. height, the remainder of the walls in the plant were built with standard 4x6-ft. panels of ⅝-in. waterproofed plywood backed up by rectangular frames of 2x4-in. timbers, with 2x4-in. struts placed on 13 ½-in. centers. Concrete was placed in wall forms made up of these panels at the rate of a 6-ft. vertical rise in 1 hr. without causing any deflection. Standard panels were used ten times on the aeration tanks and other structures. The panels were made up with 20-d. boat nails, barbed for the full length, in frames and struts, and the ⅝-in. plywood was tacked on with 6-d. cement-coated nails. Before each use, the surface of the form was painted with a mixture of castor oil and paraffin made up in the proportions of 1 qt. of castor oil to 1 gal. of paraffin. The heavy base of this mixture helped to preserve the forms for repeated use.

Personnel — For Charles H. Hurd, consulting engineer, J. A. Piersol was resident engineer in charge of construction. Richard P. Frame is city engineer of Michigan City. Operations were directed for Cope & Fisher, the contractors, by L. N. Fisher, a member of the firm, and W. R. Stonne, general superintendent in charge at the site. W. P. Cottingham was resident engineer-inspector for PWA, which aided financing of project.

FULL - HEIGHT FORM PANELS are stripped from 16-ft. exterior walls of aeration tanks and are coated with castor oil-paraffin mixture before being set up in next location.

Present and Accounted For—

A PAGE OF Personalities

LIEUT. COL. BREHON B. SOMERVELL, Corps of Engineers, U. S. Army, until recently district engineer in charge of constructing Florida ship canal, has been appointed WPA administrator for New York City, succeeding Victor F. Ridder whose resignation took effect Aug. 1. During World War Colonel Somervell served in France as assistant to chief engineer, A.E.F., and later acted as district engineer or assistant for Engineer Department in Pittsburgh, Boston, Providence, New York, Washington, Norfolk and Memphis.

SAFETY VIGILANTES. T. W. OSGOOD (left), safety engineer for Metropolitan Water District of Southern California; JAMES WESTFIELD, senior instructor, U. S. Bureau of Mines; and A. B. WOODWARD, assistant safety engineer for District, cooperate to eliminate construction hazards from tunnels and open canal sections of Colorado River aqueduct.

TUNNEL BUILDERS *(below)*. C. R. RANKIN (left), general superintendent, and E. E. McCABE, superintendent at west portal, handle difficult job in holing through San Jacinto bore of Colorado River aqueduct for Metropolitan Water District of Southern California. Large inflows of water required installation of heavy-duty pumping equipment to discharge against head of 800 ft. Advance grouting helped seal fissures in rock.

GEORGE W. CONDON, of Omaha, Neb., points out something of interest to R. M. CONNOR, superintendent for Morrison-Utah-Winston Co., general contractor for Imperial Dam and desilting works at intake end of All-American Canal, where Mr. Condon is using seventeen pneumatic-tired Euclid Trac-Trucks to move 2,000,000 cu. yd. of earth.

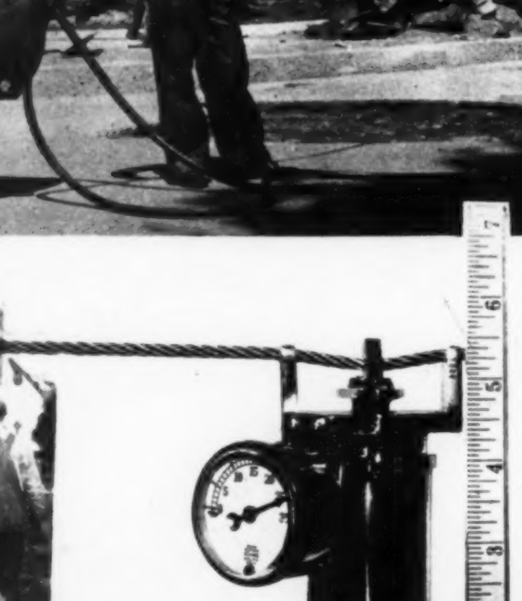
CAPT. H. L. JACQUES (standing beside sheave on shaft headframe) directs force-account construction of $8,800,000 Mono Craters project involving 11.3-mi. tunnel, collecting works, conduits and two regulating dams (one rolled earthfill and one rockfill) to extend Owens Valley water supply for city of Los Angeles, 250 mi. to south.

E. M. WHIPPLE *(right)*, construction superintendent for TVA on Chickamauga Dam, served until promotion as assistant superintendent at Pickwick Landing Dam. Earlier projects on which he directed construction include Pardee Dam, Calif., and Eleven Mile Canyon Dam, Denver.

NEW EQUIPMENT

NEWLY DESIGNED EMULSION SPRAYERS *(below)* in two models for handling drum or packaged emulsions, light oils and tars offer maximum of safety, operating efficiency and ease of handling. Features: (1) Channel iron running gear; (2) longer and smaller diameter main supply tanks; (3) pneumatic-tired Timken roller bearing wheels, semi-elliptic spring mounted on chassis; (4) pressed-steel hood over motor and compressor opens up giving easy access to all parts and, when closed, is securely locked by one latch; (5) self-filling from one drum; (6) streamlined copper tubing and fittings for piping. One unit designed for handling cut-back where heat is required has exclusive safety feature which makes it impossible to operate oil burner while pressure is being applied to main tank and to apply pressure to tank while oil burner is burning.—Littleford Bros., 443 E. Pearl St., Cincinnati, Ohio.

85-FT. BOOM on this clutch-type, especially designed dragline supplies demand for machine in 2½- to 3-cu.yd. capacity class having extra long working range. Wide spread crawlers measuring 40 in. by 19 ft. 9½ in. are self-cleaning and non-clogging and provide for exceptionally low ground pressure. Other features: Hook rollers to relieve center pin stress; anti-friction bearings and all-welded underframe construction. Equipped with 2½-cu.yd. bucket, dragline easily handles approximately 2,000 cu.yd. of material per 8-hr. shift. Powered by gasoline or diesel engine.—Marion Steam Shovel Co., Marion, Ohio.



SHUNT-TYPE CABLE TENSION INDICATOR *(left)* accurately measures and equalizes tension on small cables. Instrument weighs 17 oz., is 3½ in. high and operates on deflection principle, actual tension being obtained simply by clamping on cable. Loads from 10 to 200 lb. on small cables up to 3/16 in. in diameter can be measured accurately and quickly. Device is self-contained, automatically adjusted for temperature changes and requires no special bushings for cables of different sizes. — Martin - Decker Corp., Long Beach, Calif.

PIPE LAYER, an all-purpose pipe-handling machine designed and built for use with McCormick-Deering TracTracTor. Side boom is constructed of heavy H-beams with cast-steel header for quick attachment and removal of blocks and stiff-leg. Substantially mounted to rigid tractor frame, boom pivots on hardened steel, replaceable bushings. Legs of boom are wide-spread, enabling machine to take side pulls as well as those of lifting and lowering. When boom is raised to vertical position, safety stop prevents overthrow or bending. Special cross-drive transmission permits load and boom lines to be raised or lowered separately or simultaneously. Three speeds forward and reverse on both booms and load lines. Furnished complete with cable, blocks, stiff-leg and 2,500-lb. counterweight. — Trackson Co., Milwaukee, Wis.

TANDEM-DRIVE SPEED PATROLS *(right)*, 54 and 42 hp., provide positive traction for oil mixing and ditching, for sandy soil, steep grades, or rough, deeply furrowed roads. Features: Extra long blade base for maximum effective blade pressure; large circle (5 ft. 4 in. in diameter) for rigid moldboard mounting and "chatterproof" performance; wide front axle for greater stability; wear take-up provisions at all vital points; ball-and-socket connections and internal expanding type hydraulic brakes. Low- and high-pressure tires in 4- or 8-wheel tandem assemblies available. Speeds range from 2.3 to 10 mi. per hour. Model 42, weighing 15,350 lb., is supplied with engines using gasoline or distillate; Model 54 (weight, 17,130 lb.) is powered by gasoline, diesel fuel, or distillate.—Allis-Chalmers Mfg. Co., Tractor Division, Milwaukee, Wis.

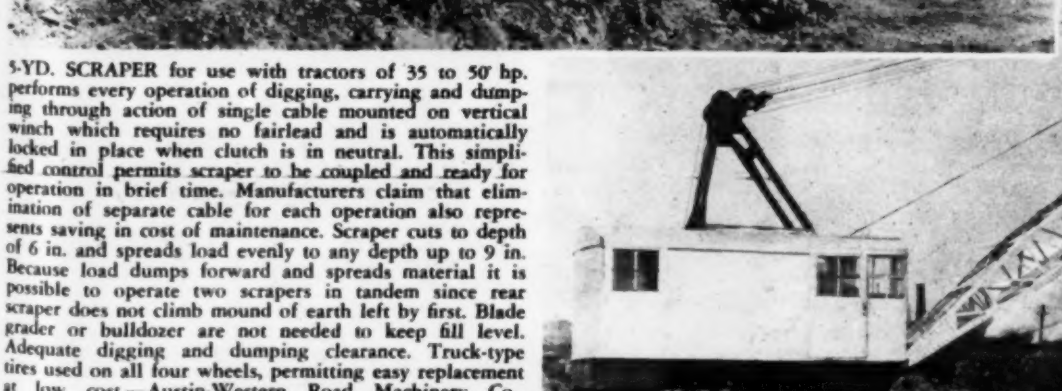
• • • On the Job

DIESEL AUTO PATROL *(right)*, road maintenance machine with compression ignition engine, is powered by 4-cylinder, 4-cycle diesel engine with 4¼-in. bore and 5½-in. stroke which develops 44 hp. at speed of 900 r.p.m. Available with either tandem or single drive. 7.00-20 tires are standard equipment on front wheels of both models. Rear wheels of tandem drive are equipped with 11.25-24 low pressure tires and dual rear wheels of single drive machine carry 9.00-24 tires. 12-ft. blades are standard on both machines. Power control levers in front of operator's seat regulate movements of blade and scarifier. Weight of tandem drive model, 15,600 lb.; single drive, 13,000.—Caterpillar Tractor Co., Peoria, Illinois.

HEAVY-DUTY DUMP TRUCKS *(above)* of 3 to 5- and 4 to 6-ton capacity are designed for economical transportation of general building supplies, coal and like materials. Six models in 3 to 5-ton class have wheelbases ranging from 153 to 185 in. and gross capacity ratings ranging from 18,000 to 20,000 lb. and from 30,000 to 35,000 lb. in tractor-trailer operation or with semi-trailer or full trailer. Three models in 4 to 6-ton class have wheelbases ranging from 156 to 190 in. and gross capacity ratings ranging from 22,000 to 40,000 lb. Special features in new models: Optional gear ratios, five-speed transmissions in certain models with double-reduction rear axles, de luxe cabs, streamlined design, rugged frames, and seven-bearing balanced crankshafts. — Reo Motor Car Co., Lansing, Michigan.

PLASTIC RUBBER *(left)* that shows only 8½ per cent shrinkage after being subjected to cold self-curing process is an economical and practical coating for rubber coating or lining work, especially for rebuilding surfaces of conveyor belts which have been worn by abrasion of materials carried. Greatly decreased shrinkage means longer life for rubber and practical elimination of all strains between rubber coating or lining and surface to which it is applied. — Self-Vulcanizing Rubber Co., Inc., 605 W. Washington Blvd., Chicago, Ill.

DIESEL-POWERED EXCAVATOR *(below)*, full revolving, of 1½-yd. capacity, increases operating speeds at lower cost per yard, according to its builders. It has been completely redesigned to take advantage of newest developments in high tensile alloy steels and use of arc-welding and every effort has been made to obtain higher ratio of horsepower per pound of weight, thus reducing effect of inertia for faster operating speeds with lower fuel consumption. Powered by 6-cylinder Caterpillar diesel engine rated at 130 hp. at 900 r.p.m. Gasoline power available. Fully convertible as shovel, dragline, crane, trench hoe, skimmer or piledriver.—Harnischfeger Corp., Milwaukee, Wis.



5-YD. SCRAPER for use with tractors of 35 to 50 hp. performs every operation of digging, carrying and dumping through action of single cable mounted on vertical winch which requires no fairlead and is automatically locked in place when clutch is in neutral. This simplified control permits scraper to be coupled and ready for operation in brief time. Manufacturers claim that elimination of separate cable for each operation also represents saving in cost of maintenance. Scraper cuts to depth of 6 in. and spreads load evenly to any depth up to 9 in. Because load dumps forward and spreads material it is possible to operate two scrapers in tandem since rear scraper does not climb mound of earth left by first. Blade grader or bulldozer are not needed to keep fill level. Adequate digging and dumping clearance. Truck-type tires used on all four wheels, permitting easy replacement at low cost.—Austin-Western Road Machinery Co., Aurora, Ill.

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***EXTRA STRONG BEAD CONSTRUCTION**

To provide strength for heavy loads, swaying loads, high loads, Goodyear truck tires have an extra-strong, heavy, braided-wire bead—wide and securely tied in by the plies of the tire. This construction insures a firm seating of tire on rim. The larger size truck tires have dual beads.

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Bears for Punishment
6 SMITH TILTERS poured practically all of the 4,364,903 yards of concrete at BOULDER DAM, helping the contractors, Six Companies, Inc. to complete the gigantic project more than TWO YEARS AHEAD OF SCHEDULE.
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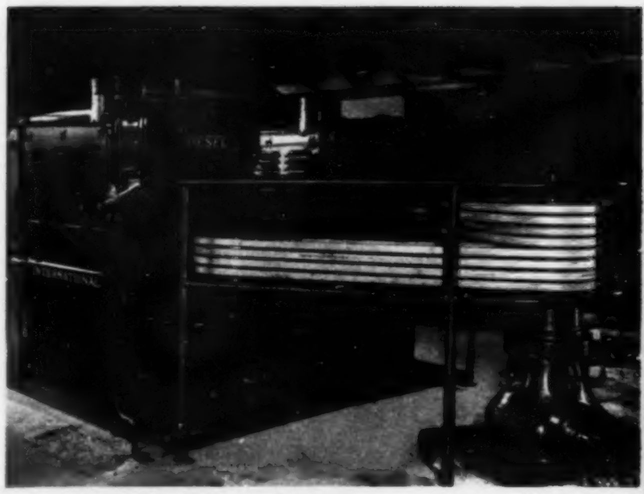

Above: **International POWER UNITS,** in a range of 12 h. p. to over 100 h. p. are highly efficient performers in a hundred fields of operation. This multiple Diesel installation is cutting pumping costs on a California ranch.

Right: **International TRACTRACTORS (crawlers).** This is the popular Model TD-40 DIESEL with crawler wagon. The elevating grader in the background is also International-powered.

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International WHEEL-Type Tractors This is the compact and sturdy Model I-12 for use wherever *space* is at a premium. There are bigger, more powerful International industrial wheel tractors, too.

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Owners and operators are intensely loyal to the all-around efficiency of *International Industrial Power.*

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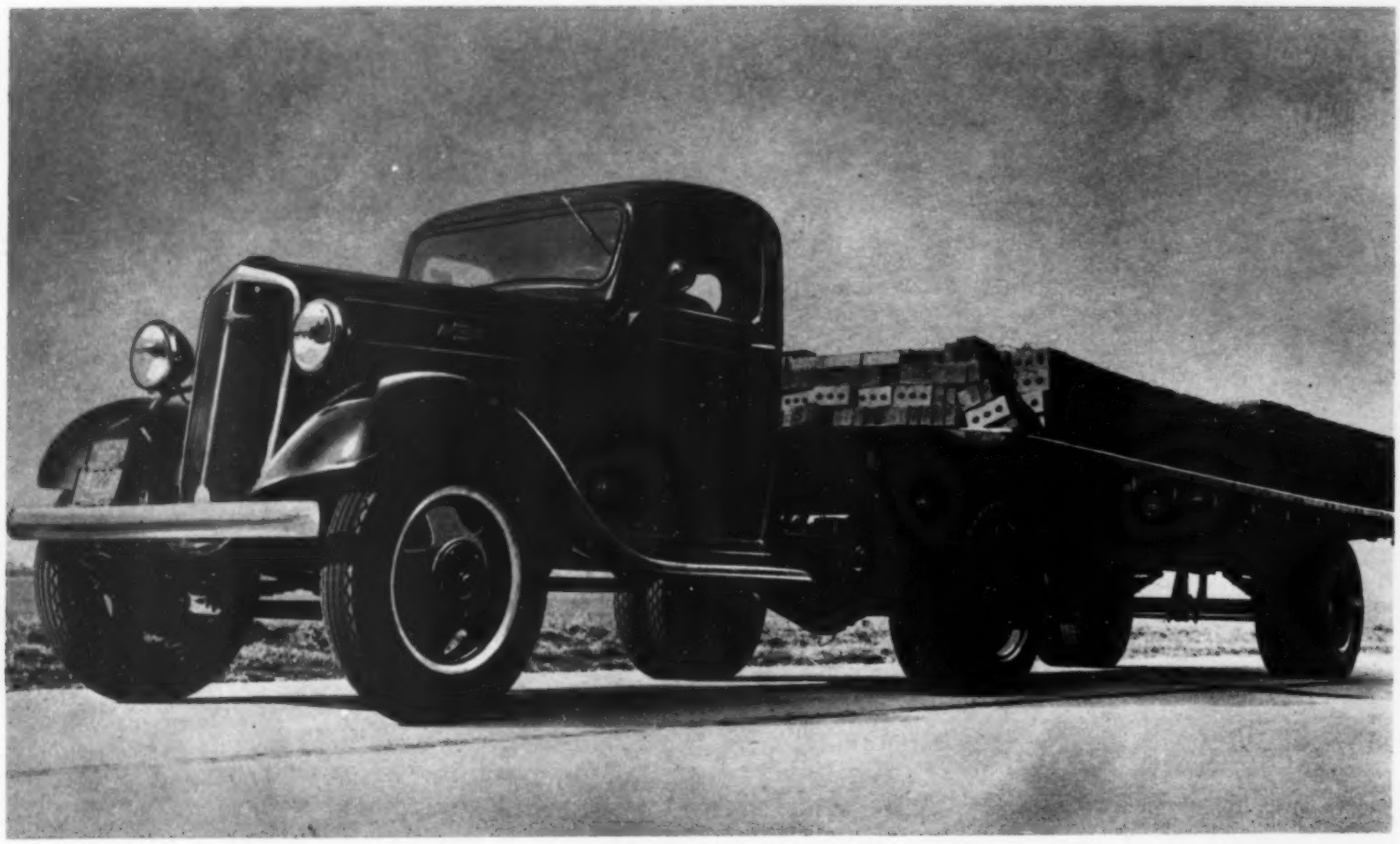
INTERNATIONAL INDUSTRIAL POWER

GASOLINE, KEROSENE, DISTILLATE, DIESEL



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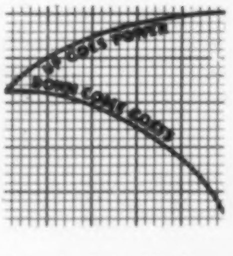
with clear-vision instrument panel for safe control



Contractors and building supply companies everywhere are purchasing low-priced, high-powered Chevrolet trucks as the equipment best suited for their haulage needs. Here are four good reasons why:

FIRST: New Chevrolet trucks have the greatest *pulling power* of any trucks in the low-price range . . . plenty of power for the heavier loads.

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with increased horsepower, increased torque, greater economy in gas and oil

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with barrel type wheel bearings on 1½-ton models

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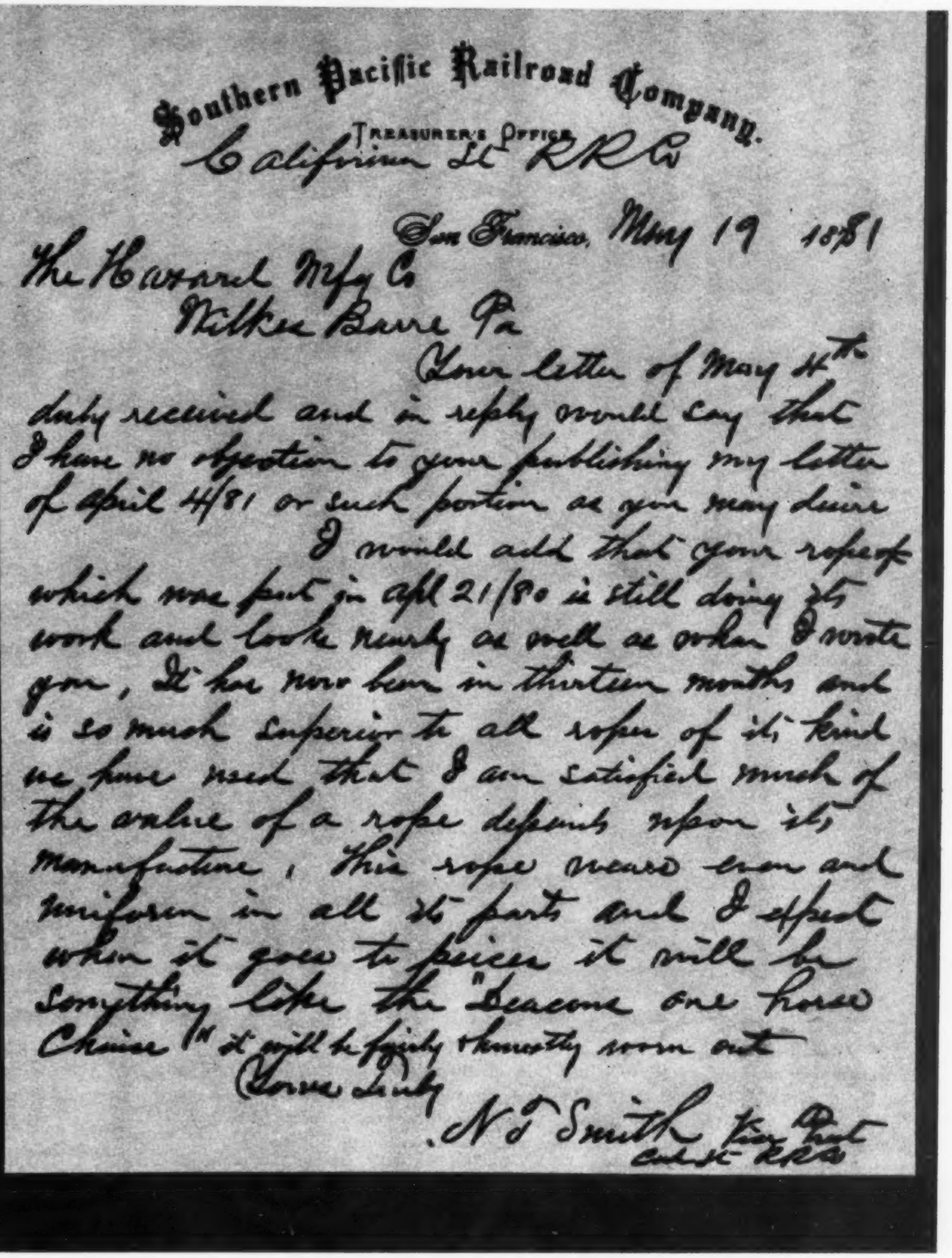


Southern Pacific Railroad Company.
Treasurer's Office
California St RR Co

San Francisco, May 19 1881

The Hazard Mfg Co
Wilkes Barre Pa

Your letter of May 4th duly received and in reply would say that I have no objection to your publishing my letter of April 4/81 or such portion as you may desire

I would add that your rope which was put in Apl 21/80 is still doing its work and looks nearly as well as when I wrote you, It has now been in thirteen months and is so much superior to all ropes of its kind we have used that I am satisfied much of the value of a rope depends upon its manufacture, This rope wears even and uniform in all its parts and I expect when it goes to peices it will be something like the "Deacons one horse Chaise" it will be fairly & smoothly worn out

Yours Truly

N T Smith Vice Prest
Calif St RRCo

GREEN SIGNIFIES SAFETY

When this letter was received in 1881, the Hazard Wire Rope Company was already 35 years old. Old enough to have received many such letters of testimony to the quality of Hazard products and the fairness of Hazard policies.

Amongst our present customers there are many who have bought Hazard ropes *continuously*, for 30, 40, and 50 years. More recently (since 1928), they have learned the unusual service-life of LAY-SET Preformed.

When *you* buy Hazard LAY-SET you not only get the value characteristic of preformed rope but you get the benefit of the accumulated experience of ninety years.

HAZARD WIRE ROPE COMPANY, Inc., WILKES-BARRE, PENNSYLVANIA

An Associate Company of American Chain Company, Inc.

In Business for Your Safety

District Offices: New York • Chicago • Philadelphia • Pittsburgh • Fort Worth
San Francisco • Denver • Los Angeles • Birmingham • Tacoma

LAY-SET *Preformed* Wire Rope

ALL HAZARD WIRE ROPES MADE OF IMPROVED PLOW STEEL ARE IDENTIFIED BY THE GREEN STRAND

TEN DAYS

then

A ROAD LIKE THIS!

Calcium-Chloride-stabilized section of Ohio State Route 35, between the cities of Chillicothe and Washington Court House.

WITH STABILIZATION

WE MIGHT go on from now 'til doomsday, extolling the merits of stabilization but, after all, the proof is in the pudding. That's why we want to tell you an experience of the Ohio State Highway Department, as reported by T. E. Morgan, Assistant Division Engineer.

Last fall, after a newly-built gravel road lacked support value and was rejected by traffic, it was decided to stabilize the section. To use Mr. Morgan's words:

"We started immediately and ten days later the four-mile section was completed and opened to traffic with a six-inch compacted 'clay concrete' slab of coarse and fine aggregate and clay cement, with calcium chloride as the chemical aid to stability. The section is still open to traffic, in excellent condition and carrying an average of 1500 cars daily, of which a considerable percentage consists of heavy coal trucks on long hauls.

". . . there must be something to a theory that will provide for converting a road, thoroughly objectionable to traffic, into one entirely satisfactory to traffic, from the standpoint of support value, in the short period of ten days. Moreover, more aggregate was incorporated in that section in proper proportions in the ten-day period than could be incorporated in improper proportions in ten years by the traffic bound method, to say nothing of the wasting away of aggregate and the additional aggregate required from year to year, with its incidental maintenance costs."

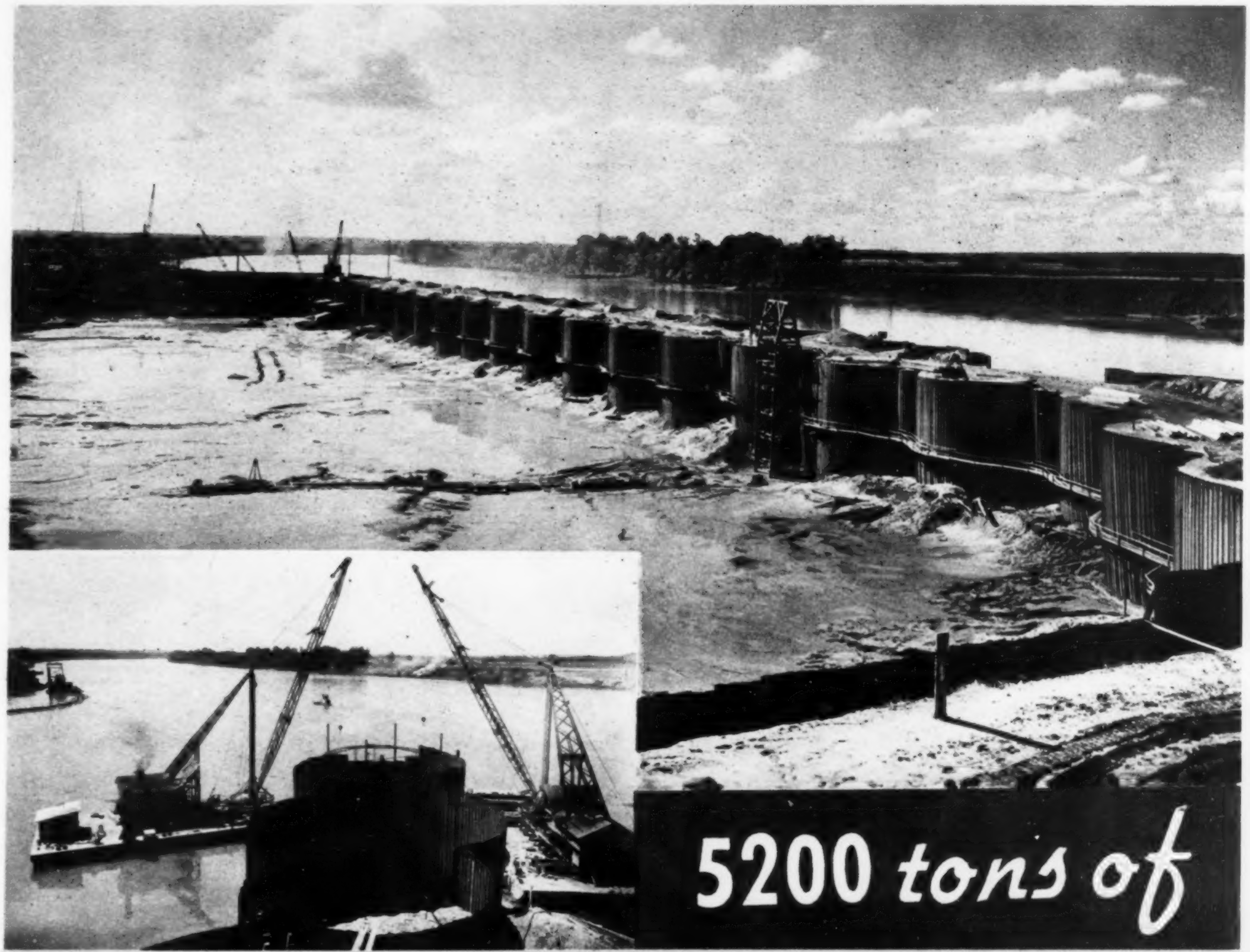
Road officials everywhere are having similar experiences with calcium-chloride-stabilization. Write today for technical bulletins and complete information on how to build and maintain low-cost, all-weather stabilized roads.

Calcium Chloride Association

The Dow Chemical Company, Midland, Mich.
Solvay Sales Corporation, 40 Rector St., New York City
The Columbia Alkali Corporation, Barberton, Ohio
Michigan Alkali Company, 60 E. 42nd St., New York City

CALCIUM CHLORIDE

F O R   S T A B I L I Z I N G   R O A D   S U R F A C E S



5200 *tons of*

BETHLEHEM *Steel Sheet* PILING

in Pickwick Landing Project

AT Pickwick Landing Dam on the Tennessee River the problem was to build a dam and a lock for the navigable channel. A cofferdam was needed which would be economical to construct yet amply strong to withstand the full force of the river.

A cellular cofferdam, approximately 1500 feet long, was built of 15-in. x 3/8-in. Bethlehem Straight-Web Sections (SP6). Each of the circular cells was 59 ft. in diameter and was filled with sand and gravel removed from the lock bed. 50-ft. sections of Bethlehem Steel Sheet Piling were used on the lock side of the cofferdam and 55-ft. sections on the river side—both lengths of piling being driven to bed rock. A total of 5200 tons of Bethlehem Steel Sheet Piling was used in this project.

This Pickwick Landing Cellular Cofferdam, one of the largest ever constructed, is but one of numerous similar projects in which Bethlehem Steel Sheet Piling is being used throughout the country. The great size of the cofferdam and the ease and rapidity with which it was built are indicative of the efficiency with which many types of foundation work may be executed with Bethlehem Steel Sheet Piling.

BETHLEHEM STEEL COMPANY, *General Offices:* Bethlehem, Pa. *District Offices:* Albany, Atlanta, Baltimore, Boston, Bridgeport, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Honolulu, Houston, Indianapolis, Kansas City, Los Angeles, Milwaukee, New York, Philadelphia, Pittsburgh, Portland, Ore., Salt Lake City, San Antonio, San Francisco, St. Louis, St. Paul, Seattle, Syracuse, Washington, Wilkes-Barre, York. *Export Distributor:* Bethlehem Steel Export Corporation, New York.

BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL

Save Time · Cut Costs · Make Money with

Armco Dredge Pipe

1 Much money was saved on this big Fausse Pointe job by the use of long-wearing Armco Dredge Pipe.
2 Another important project in which easy-handling, abrasion-resisting Armco Dredge Pipe proved its worth—on the Little River in South Carolina.

● If ever a pipe was made to order for your dredging contracts, it's Armco *Special Analysis* Dredge Pipe. Like Armco Pipe for water lines and industrial uses, this type is also spiral welded for greater strength—only it's made of a tough, abrasion-resisting steel.

Listen to what an old-time dredge captain says of Armco Dredge Pipe . . . "the tightest shore-pipe joint I ever saw, and the easiest to lay and break out."

That's because Armco shore-pipe joints are precision-made by machine. And Armco Spiral Welded Dredge Pipe is "balanced," rolls handily and speedily to position. Diameters run from 6″ to 36″, wall thicknesses from ⅛″ to ½″.

Besides the shore type, there is also Armco Pontoon Pipe—long lengths of tremendous strength and endurance that weather rough water and stand up under wear and tear. And for pontoons you can use durable Armco Ingot Iron, or Steel, made complete in various sizes with special saddles and brackets to your own specified design.

Just send your specifications to us—or write for full information. The American Rolling Mill Company, Pipe Sales Division, Middletown, Ohio.

3 Center Above: Armco Dredge Pipe is quickly strung by supervised unskilled labor as in this picture of a Toledo, Ohio job.
4 Above: Used with Armco Dredge Pipe, this popular machine-made shore-pipe joint eliminates leakage and consequent abrasion, thus insuring utmost economy of service.

HERE ARE SOME REAL ADVANTAGES

Reduced pumping costs • Strong tight-fitting joints
Extra abrasion resistance • Extreme high strength

ARMCO DREDGE PIPE

IT'S BALANCE that counts !
Handles of Sterling barrows are made of No. 1 clear hard maple. The absence of knots eliminates breakage. Bolt holes are drilled in center of handles so that handles are interchangeable. On contractors barrows handles are connected at front end by a malleable wheel guard that has the correct angle for easy dumping.
An important item in the construction of wheelbarrows is the type of leg. The legs must be strong enough to withstand dropping and sliding of a loaded barrow, and high enough so that barrow can be lifted for wheeling with a minimum of effort.
Sterling legs give proper height to handles. They are made of channel steel and connected by a channel cross brace. For rigidity the cross member is connected to legs by diagonal braces. Legs are entirely riveted and are equipped with steel shoes, which can be replaced, if necessary.
it's not a Sterling without the S
STERLING WHEELBARROW CO.
900 SOUTH 71ST STREET
MILWAUKEE · WISCONSIN U.S.A.

EACH HEAD CAN TURN TWO DIFFERENT-SIZED NUTS

This is a great advantage over Ratchet Wrenches that turn only one nut in each head, as it means fewer parts to keep on hand.

This head turns 1 in. and 1⅛ in. Hexagon nuts, U. S. Standard.

THE FAVORITE REVERSIBLE RATCHET WRENCH

means greater efficiency and speed in nut turning, as you can use one side of head for one size nut, and by turning it over you can use the other side for a different-sized nut.

TWO WRENCHES IN ONE

Reverse motion instantaneous by simply turning pawl.

Opening clear through head. A great time-saver on construction work.

Wrench head does not leave nut until operation is completed.

Each handle takes five different - sized heads.

Send for Full Particulars

GREENE, TWEED & CO.

Sole Manufacturers

109 DUANE STREET NEW YORK, N. Y.

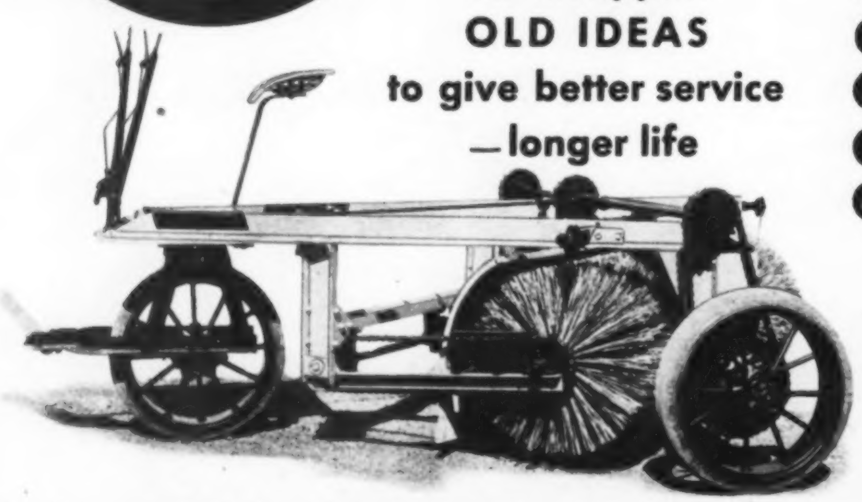
---

6 REASONS why RELIANCE will give you the MOST SERVICE for the lowest ultimate cost...

WE scrapped OLD IDEAS to give better service —longer life

1. Three wheel chassis provides 3 point suspension, giving short turning radius, making unit extremely easy to handle and steer.
2. New method for raising and lowering broom providing quick, easy, positive control.
3. Broom mounted diagonally across frame at point usually occupied by rear axle; no counterweight required.
4. Frame all steel construction, of great strength and durability, yet considerably lighter than similar equipment of other types.
5. The broom is engaged or disconnected through jaw type clutch. Control levers within easy reach.
6. Clutch held firmly in position when operating broom, by a heavy coil spring.

The Reliance is backed by 30 years manufacturing experience. It is the BEST BUY in today's street sweeper market! Reliance offers a complete line of Rock Crushers; Bucket Elevators; Revolving Screens; Scarifiers; Storage Bins; Pulverizers; Car Unloaders; Chip Spreaders; Heating Kettles; Bin Gates; Feeders; Belt Conveyors; Grizzlies; Air Separators; Sand & Gravel Spreaders; Wash Boxes.



Reliance 3 Wheel Rubber Tired Sweeper

Designed especially for preparing highways for resurfacing

UNIVERSAL ROAD MACHINERY CO.

KINGSTON, N. Y.

New York Office 114 Liberty St.

TOUGH TIRE JOBS LICKED

This Goodrich-equipped portable shovel is stripping dirt and loose rock from a limestone deposit in Illinois.

HOW NEW GOODRICH SILVERTOWNS SET RECORDS on CONSTRUCTION JOBS

• Now you can get a tire built especially to stand up on the toughest hauling jobs in the construction industry. It's the new Triple Protected Silvertown—the tire that ends worries about sidewall breaks.

In most truck tires the sidewall is the weak spot—80% of the premature failures occur right there. So Goodrich built a tire with Triple Protection at the "Failure Zone." This invention makes the tire just as strong in the sidewall as it is under the tread. The yanking, twisting, flexing action that ruins many tires is positively checked by Triple Protection!

Don't Take Chances

One tire failure on an important job may cost you hours of delay—men and equipment idle—a big repair bill. Why not play safe? Get the only tire that has this 3-way protection:

1. PLYFLEX—distributes stresses throughout the tire—prevents ply separation—checks local weakness.

2. PLY-LOCK—protects the tire from breaks caused by short plies tearing loose above the bead.

3. 100% FULL-FLOATING CORD—eliminates cross cords from *all* plies—reduces heat in the tire 12%.

Talk to a Goodrich dealer. Ask him to show you the tire that shrinks costs and stretches mileages. There's no premium price to pay.

For information on any tire problem write The B. F. Goodrich Co., Akron, Ohio.

Ray Beseker, driver for the Laura Gravel and Stone Co., Phillipsburg, Ohio, says, "I've driven trucks for 15 years but I've never seen tires that stand up like these new Silvertowns."

Hauling bricks means heavy loads. This Indiana contractor uses Goodrich Silvertowns exclusively.

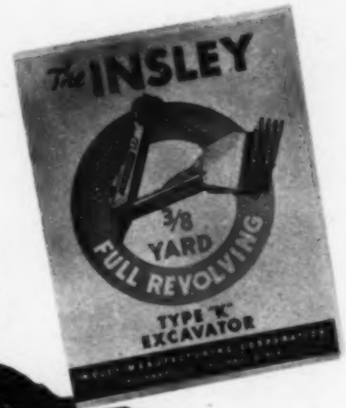
Up and over goes this Continental Wagon Scraper. Triple Protected Silvertowns carry the load through any kind of soil.

Goodrich *Triple Protected* **Silvertowns**

SPECIFY THESE NEW SILVERTOWN TIRES FOR TRUCKS AND BUSES

The INSLEY Type "K"

3/8 YD. FULL REVOLVING EXCAVATOR



Here we show one of three INSLEY type "K" shovels sold to this customer.

CATALOG No. 112 will explain fully—May we send you a copy?

INSLEY MFG. CORP. OLNEY & E. ST. CLAIR **INDIANAPOLIS, IND.**

Shovels, Trench Hoe Excavators, Draglines, Clamshells, Cranes, Derricks, Wagons, Shoulder Finishers, Cars, Buckets, Hoppers, Carts, Concrete Placing Equipment

---

Introducing a NEW STERLING PUMP

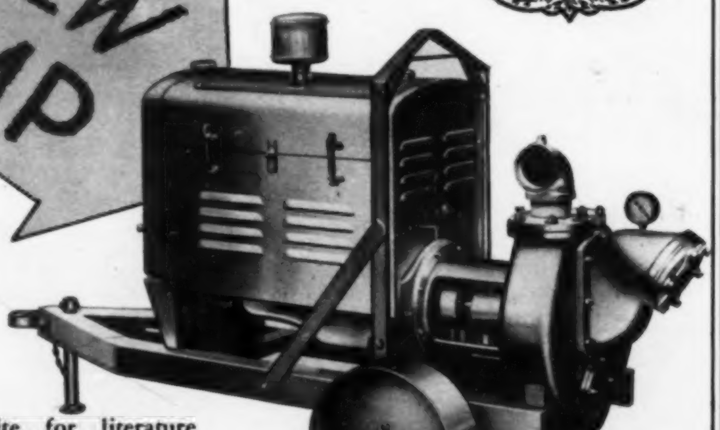
SIMPLE
DEPENDABLE
RUGGED

A complete new line of self priming centrifugal pumps ranging in size from 2" to 8" that are years ahead in design.

STERLING QUALITY

Sterling's contribution to construction equipment;

Modern in every detail; Leading in every procession; Reaching back into yesterday's treasure house of experience; Using something of tomorrow in design and releasing the finished product today — Sterling keeps everlastingly in front.



Sterling
MACHINERY CORPORATION
411-13 Southwest Blvd. Kansas City, Mo.

Write for literature on this new line of self priming centrifugal pumps.

Capacity... Economy... Style

IN GMC MEDIUM AND HEAVY DUTY TRUCKS

A GMC is just the truck for business men with big, bulky loads that call for a vehicle of ample size and with the stamina and economy to assure greater savings or earnings.

Take the GMC 3-ton, at only $895 chassis f.o.b. Pontiac. On the score of performance you can safely place your faith in such features as GMC valve-in-head engine, truck-built clutch, heavy-duty transmission, roller-bearing steering, set-back front axle and massive full-floating rear axle.

Economy features include down-draft carburetor, oil bath air cleaner, complete full-pressure lubrication, exhaust valve seat inserts, oil filter, removable main bearings and many other quality refinements.

And so eye-arresting is the advanced streamlined styling of this big, rugged GMC that owners can place a real dollars-and-cents value on such fine appearance. All in all, this modern GMC in the 3-ton range as well as every other type in the medium and heavier-duty ranges is truly an exceptional value—one that is a challenge to the field, especially when price is considered.

GMC THE TRUCK OF VALUE

½ TO 15 TONS

Time payments available through our own Y. M. A. C. 6% plan.

GENERAL MOTORS TRUCKS AND TRAILERS

GENERAL MOTORS TRUCK COMPANY, PONTIAC, MICHIGAN

7 feet more room for the big trucks. Truss braces were replaced by gusset plates. "*Shield-Arc*" welded.

Reinforcing rods for Colorado River Aqueduct's 16-ft. concrete pipe are "*Shield-Arc*" welded.

Courtesy American Concrete & Steel Pipe Co.

Costly construction equipment can be kept in first class working condition when Lincoln welding machines and electrodes are handy.

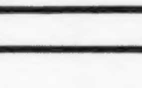
"This business of getting profits out of the welding arc is simple with a '*Shield-Arc*' welder because you can weld *more* jobs and do them *better, quicker* and at *less cost* than with any other welder.

"One big reason for the *broad utility* of a '*Shield-Arc*' is its

DUAL ARC CONTROL

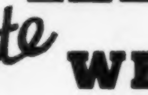
"By that I mean, its arc *heat* and its arc *penetration* can be varied independently of each other. You can get the *right* arc to suit sheet metal, heavy plate, cast iron, aluminum, hard-facing work—any repair or fabrication job you have on hand.

Any PENETRATION . . . Any HEAT . . . For Any JOB



Light penetration, low heat for light work.

Heavy penetration, any heat for overhead and vertical welding.



Heavy penetration, high heat for heavy work.

"If you want your work to roll along smoothly, roll a '*Shield-Arc*' onto the job. You'll find it the most valuable schedule-beater you ever owned! Just roll the coupon along to THE LINCOLN ELECTRIC COMPANY." Dept. G-286, Cleveland, Ohio. Largest Manufacturers of Arc Welding Equipment in the World.

THE LINCOLN ELECTRIC CO., Dept. G-286, Cleveland, Ohio

Please send me data on "*Shield-Arc*," the Complete Welder.

Firm ____________________

Name ____________________

Position ____________________

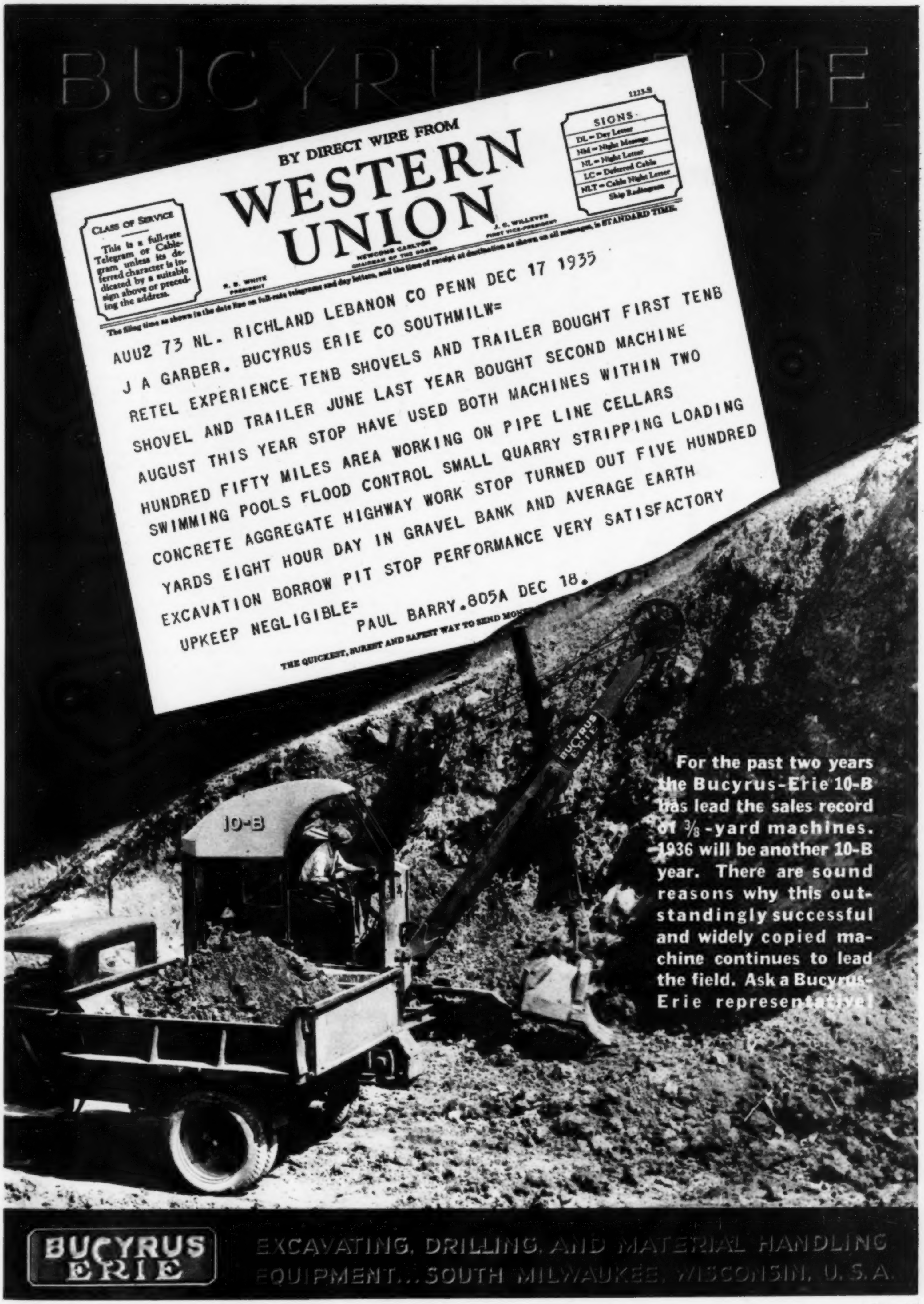
Address ____________________

City ____________________

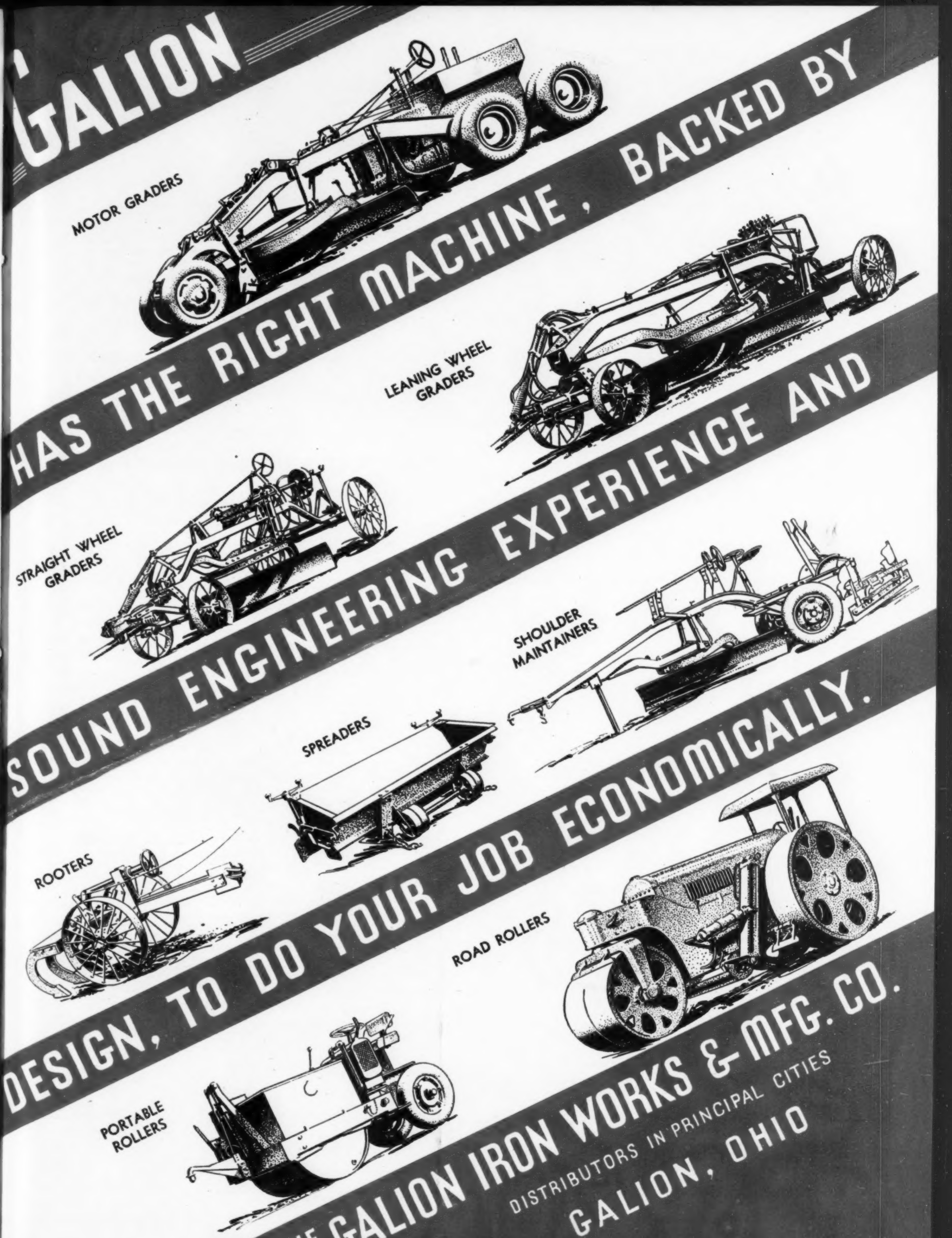
State ____________________

"SHIELD-ARC"

THE ONLY *complete* WELDER



BUCYRUS ERIE
BY DIRECT WIRE FROM
WESTERN UNION
CLASS OF SERVICE
This is a full-rate Telegram or Cablegram unless its deferred character is indicated by a suitable sign above or preceding the address.
SIGNS
DL = Day Letter
NM = Night Message
NL = Night Letter
LC = Deferred Cable
NLT = Cable Night Letter
Ship Radiogram
AUU2 73 NL. RICHLAND LEBANON CO PENN DEC 17 1935
J A GARBER. BUCYRUS ERIE CO SOUTHMILW=
RETEL EXPERIENCE TENB SHOVELS AND TRAILER BOUGHT FIRST TENB
SHOVEL AND TRAILER JUNE LAST YEAR BOUGHT SECOND MACHINE
AUGUST THIS YEAR STOP HAVE USED BOTH MACHINES WITHIN TWO
HUNDRED FIFTY MILES AREA WORKING ON PIPE LINE CELLARS
SWIMMING POOLS FLOOD CONTROL SMALL QUARRY STRIPPING LOADING
CONCRETE AGGREGATE HIGHWAY WORK STOP TURNED OUT FIVE HUNDRED
YARDS EIGHT HOUR DAY IN GRAVEL BANK AND AVERAGE EARTH
EXCAVATION BORROW PIT STOP PERFORMANCE VERY SATISFACTORY
UPKEEP NEGLIGIBLE=
PAUL BARRY.805A DEC 18.
THE QUICKEST, SUREST AND SAFEST WAY TO SEND MONEY
10-B
BUCYRUS ERIE
For the past two years the Bucyrus-Erie 10-B has lead the sales record of 3/8-yard machines. 1936 will be another 10-B year. There are sound reasons why this outstandingly successful and widely copied machine continues to lead the field. Ask a Bucyrus-Erie representative!
BUCYRUS ERIE
EXCAVATING, DRILLING, AND MATERIAL HANDLING EQUIPMENT... SOUTH MILWAUKEE, WISCONSIN, U.S.A.



GALION
HAS THE RIGHT MACHINE, BACKED BY
SOUND ENGINEERING EXPERIENCE AND
DESIGN, TO DO YOUR JOB ECONOMICALLY.
MOTOR GRADERS
LEANING WHEEL GRADERS
STRAIGHT WHEEL GRADERS
SHOULDER MAINTAINERS
SPREADERS
ROOTERS
ROAD ROLLERS
PORTABLE ROLLERS
THE GALION IRON WORKS & MFG. CO.
DISTRIBUTORS IN PRINCIPAL CITIES
GALION, OHIO

EQUIPMENT and MATERIALS

An index of products made by manufacturers whose advertisements appear in this issue of Construction Methods.

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Texas Company
ASPHALT PLANTS
Blaw-Knox Company
Hetherington & Berner, Inc.
BACK FILLERS
Austin-Western Road Mchry. Co.
Harnischfeger Corp.
Link Belt Co.
Northwest Engineering Co.
BARS, IRON AND STEEL
American Rolling Mill Co.
Bethlehem Steel Co.
Inland Steel Co.
BATCHERS, ADJUSTABLE MEASURING
Blaw-Knox Company
Heltzel Steel Form & Iron Co.
BELTING
Goodall Rubber Co.
Goodrich Rubber Co., B. F.
Goodyear Tire & Rubber Co.
BINS, STORAGE
Blaw-Knox Company
Chain Belt Company
Heltzel Steel Form & Iron Co.
BLASTING ACCESSORIES
Atlas Powder Co.
Du Pont de Nemours & Co., E. I.
Ensign-Bickford Co.
BOLTS, NAILS, NUTS, RIVETS and SPIKES
Bethlehem Steel Co.
Inland Steel Co.
International Nickel Co., Inc., The
BOOKS, ENGINEERING
McGraw-Hill Book Co.
BOOTS, RUBBER
Goodall Rubber Co.
BUCKETS
Blaw-Knox Company
Bucyrus-Erie Co.
Harnischfeger Corp.
Insley Mfg. Company
Northwest Engineering Co.
Owen Bucket Co.
Page Engineering Co.
BUILDINGS, STEEL
Blaw-Knox Company
BULLDOZERS
Le Tourneau, Inc., R. G.
CABLEWAYS
Roebling Son's Co., J. A.
CABLE, ELECTRIC
Roebling Son's Co., J. A.
CALCIUM CHLORIDE
Calcium Chloride Assn.
CARS, AIR DUMP, INDUSTRIAL, ETC.
Bethlehem Steel Co.
CARTS, CONCRETE
Sterling Wheelbarrow Co.
CASTINGS, IRON & STEEL (alloy)
International Nickel Co., Inc., The
CEMENT
International Cement Corp.
Portland Cement Assoc.
Universal Atlas Cement Co.
(U. S. Steel Corp. Subsidiary)
CEMENT (BULK) HANDLING EQUIP.
Barber-Greene Co.
Blaw-Knox Company
Chain Belt Company
Heltzel Steel Form & Iron Co.

If you do not find all you need in the advertising section, we shall be glad to assist you. Write to —

CONSTRUCTION METHODS
Information Bureau
330 West 42nd St. New York City

CHAIN STEEL & MALLEABLE SPROCKET
Chain Belt Company
Link Belt Co.
CHUTES, CONCRETE
Insley Manufacturing Co.
COMPRESSORS, AIR
Allis-Chalmers Mfg. Co.
Schramm, Inc.
CONCRETE CURING MATERIAL
Calcium Chloride Assn.
CONCRETE REINFORCEMENT
Inland Steel Co.
Wickwire Spencer Steel Co.
CONCRETE SLAB RAISING EQUIPMENT
Koehring Company
CONVEYING & STORAGE SYSTEMS
Barber-Greene Co.
Chain Belt Company
Link Belt Co.
CONVEYORS, BELT, BUCKET & CHAIN
Barber-Greene Co.
Chain Belt Company
Link Belt Co.
Wickwire Spencer Steel Co.
CRANES, GAS, ELECTRIC, DIESEL & STEAM
Austin-Western Road Mchry. Co.
Bucyrus-Erie Co.
Clyde Sales Co.
Harnischfeger Corp.
Koehring Company
Link Belt Co.
Northwest Engr. Co.
Thew Shovel Co.
Universal Crane Co.
CRANES, MOTOR TRUCK
Thew Shovel Co.
Universal Crane Co.
CRUSHERS & PULVERIZERS
Acme Road Mchry. Co.
Allis-Chalmers Mfg. Co.
Austin-Western Road Mchry. Co.
Galion Iron Works & Mfg. Co.
Universal Road Mchry. Co.
CULVERTS
Austin-Western Road Mchry. Co.
DERRICKS & DERRICK FITTINGS
Clyde Sales Co.
Harnischfeger Corp.
DRAGLINES
(See Cranes & Shovels)
DRAWING PAPER
Wade Instrument Co.
DREDGES
Bucyrus-Erie Co.
Harnischfeger Corp.
DRILLS
Schramm, Inc.
DRILLS, ELECTRIC
Syntron Co.

DRILLS, WAGON
Bucyrus-Erie Co.
DYNAMITE
Atlas Powder Co.
Du Pont de Nemours & Co., E. I.
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Chain Belt Company
Link Belt Co.
ELEVATORS, CONTR. MATERIAL
Barber-Greene Co.
Chain Belt Company
Galion Iron Works & Mfg. Co.
Link Belt Co.
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Allis-Chalmers Mfg. Co.
Wilson, K. R.
ENGINES, STATIONARY, DIESEL & GAS
Caterpillar Tractor Co.
Wilson, K. R.
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Austin-Western Road Mchry. Co.
Bucyrus-Erie Co.
Harnischfeger Corp.
Insley Mfg. Company
Koehring Company
Link Belt Co.
Northwest Engr. Co.
Page Engineering Co.
Thew Shovel Co.
Universal Crane Co.
EXCAVATORS, DITCH & TRENCH
Barber-Greene Co.
Bucyrus-Erie Co.
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Koehring Company.
Link Belt Co.
Northwest Engr. Co.
Thew Shovel Co.
Universal Crane Co.
EXPANDED METAL
American Rolling Mill Co.
Bethlehem Steel Co.
EXPLOSIVES
Atlas Powder Co.
Du Pont de Nemours & Co., E. I.
FLOORING
Barrett Company
Texas Company
FLOOR PLATES, STEEL
Inland Steel Co.
FORGINGS
International Nickel Co., Inc., The
FORMS, CONCRETE
Blaw-Knox Company
Heltzel Steel Form & Iron Co.
FUSE, BLASTING
Atlas Powder Co.
Ensign-Bickford Co.
GENERATORS, ELECTRIC
Electric Tamper & Equipment Co.
Lincoln Electric Co.

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Acme Road Mchry. Co.
Allis-Chalmers Mfg. Co.
Austin-Western Road Mchry. Co.
Blaw-Knox Company
Caterpillar Tractor Co.
Galion Iron Works & Mfg. Co.
GRAVEL WASHING PLANTS
Austin-Western Road Mchry. Co.
Galion Iron Works & Mfg. Co.
GRINDERS
White Manufacturing Co.
GUARD RAILS, HIGHWAY
Hazard Wire Rope Co.
Wickwire Spencer Steel Co.
HAMMERS, ELECTRIC
Syntron Co.
HOISTS GAS, ELECTRIC, DIESEL & STEAM
Allis-Chalmers Mfg. Co.
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Construction Machinery Co.
Harnischfeger Corp.
Sterling Machinery Corp.
HOISTS, HAND
Chain Belt Company
Sterling Machinery Corp.
HOSE, AIR, WATER & STEAM
Goodall Rubber Co.
Goodrich Rubber Co., B. F.
Goodyear Tire & Rubber Co.
INSERTS, CONCRETE
Bethlehem Steel Co.
JOINTS, PAVING
Barrett Company
Texas Company
LATH, EXPANDED METAL
Wickwire Spencer Steel Co.
LIGHTING PLANTS
Sterling Machinery Corp.
LINER PLATES, STEEL
Blaw-Knox Company
Ingot Iron Railway Products Co.
LOADERS, PORTABLE
Barber-Greene Co.
Link Belt Co.
LUBRICANTS
Alemite Corp. (Div. Stewart Warner)
Gulf Refining Co.
Roebling Son's Co., J. A.
Texas Company
LUBRICATING SYSTEMS
Alemite Corp. (Div. Stewart Warner)
MAINTAINERS, ROAD
Allis-Chalmers Mfg. Co.
Austin-Western Road Mchry. Co.
Galion Iron Works & Mfg. Co.
MIXERS, CONCRETE & MORTAR
Chain Belt Company
Construction Machinery Co.
Jaeger Machine Co.
Koehring Company
Smith Co., T. L.
MIXERS, PAVING
Chain Belt Company
Koehring Company
Smith Co., T. L.

MIXERS, TRUCK
Blaw-Knox Company
Chain Belt Company
Jaeger Machine Co.

MIXING PLANTS, CENTRAL
Blaw-Knox Company
Chain Belt Company
Jaeger Machine Co.

MOTORS, ELECTRIC
Harnischfeger Corp.
Lincoln Electric Co.

PAINTS
Barrett Company
Du Pont de Nemours & Co., E. I.

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